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We celebrate this twenty-first issue of *Oil Palm News* with the larger A4 size and new format.

A number of factors, including the absence of the Editor on overseas duties, has delayed publication of this issue but this has enabled reference to be made to the International Agricultural Oil Palm Conference and Palm Oil Processing and Marketing Symposium held in Kuala Lumpur in June 1976.

The attendance of over 700 participants at the Agricultural conference included representatives from producing countries in West Africa and Latin America together with Indonesia and Papua New Guinea as well as Malaysia. The announcement of the successful vegetative propagation of oil palms by Unilever Research, Colworth/Welwyn Laboratory, UK, using tissue culture methods and the successful establishment of resulting clonal plantlets at Unipalmol Malaysia Sdn Bhd, Layang Layang, Johore, in the first paper to be presented could have far-reaching implications in the future both for oil palm breeding and possibly for breeding other commercial palms such as the coconut and the date. The technique however needs to be developed to allow large-scale production of clonal material for commercial planting.

The paper in this issue by Mlle Jacobsberg reviews the Palm Oil Symposium which followed the Agricultural Conference and the Editor's paper presented at the Symposium is also published here.

Many requests are received by the Tropical Products Institute for photocopies of articles referred to in *Oil Palm News* under 'Recent Publications'. Although photocopies of articles can be provided in cases of difficulty, the Institute's photocopying resources are limited and readers are asked to apply to the authors of the articles for reprints in the first instance; the authors' addresses are normally given. Alternatively, the publications are frequently available at University or Research Station libraries in the inquirer's own country, and photocopies can often be obtained from these.

The Editor would be glad to receive articles and comments for the 22nd and future issues of *Oil Palm News* as soon as possible.

Malaysian International Symposium on Palm Oil Processing and Marketing 1976, Review Paper*

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Since the last Incorporated Society of Planters Symposium in 1969 on the quality and marketing of oil palm products, general interest in palm oil has been steadily increasing. Almost every year a 'Palm Oil Symposium' took place in countries which are high consumers of palm oil.

The basic reasons are the increasing availability of palm oil at highly competitive prices with regard to other edible oils (36), and to its flexibility in utilization, thanks to the progress of modern technology.

In Malaysia, besides the increasing number of oil mills linked to the steady increase of production, which represents an annual rate of 24%, palm oil processing plants are being established for refining and also for manufacturing end products.

It is certain that a great effort goes into this new aspect of the Malaysian oil palm industry; however, the problems linked to the production of palm oil itself are certainly not all solved. There is still ample work to be done and this is reflected in the orientation of the contributions to the present symposium.

An important point is that, given the considerable bulk of the present production in Malaysia, palm oil, be it crude or processed, is primarily a product for export. Hence, at all stages of its elaboration this target must be kept in mind (36).

Processing technique and control

It is noteworthy that the importance of sampling and rational process control is now appreciated by Malaysian palm oil producers (33). Every contribution in this field will help to improve the accuracy and efficiency of production control, and of quality evaluation. Given the heterogeneity of the fruit bunches, the processing efficiency must be controlled by monitoring oil losses in the wastes and effluent (33, 37). Efforts have been made to improve the reliability of the estimates by increasing the homogeneity of the samples. Thus it has been recommended to sample spikelets instead of the total bunch stalks (7); and for sampling of press fibre, to use a mechanical rotary cutter to homogenize fibre, mesocarp and kernels before sub-sampling (20). Also, means of process control have been highlighted (33).

It is hoped that standard methods will be achieved for sampling since this is imperative if one is to evaluate the quality of palm oil on a marketing basis. This requires a sound knowledge of the theoretical basis of sampling (17), which will need to be heeded in practice. Since interest in sampling problems is now quite manifest, there should be no major obstacle to standardizing. However, the problems must be studied very thoroughly because of the wide practical implications. Exchange of views and further experimentation in this field are very desirable.

Milling (25)

Although milling of palm fruit can now look back on the practical industrial experience of over half a century, there is still room for improvement. Fundamental changes in the extraction process, such as direct solvent extraction, are not to be expected in the near future, as it was found that yield and quality were unsatisfactory. Also, the characteristics of solvent extracted oil diverge from normal pressed oil (11, 14, 25). However, solvent extraction of palm kernel oil is carried out (7). Optimization of milling equipment is currently under consideration.

An important improvement in the clarification step could be the stirring of the diluted crude oil in the continuous settling tank, as this seems to reduce the apparent viscosity of the oil and to favour settling (21). The fact that the waste material is obtained in a smaller volume, due to reduced dilution, can in itself be valuable, especially from the angle of pollution problems. Other improvements, such as feeding oil to the centrifuge via rotary brush strainers to reduce the oil loss, have been elaborated (9, 21).

Manufacturers endeavour to adjust the milling equipment for maximum efficiency and long life, and to meet the more demanding requirements regarding quality, yield and throughput rates, by working in close co-operation with the users in order to reach a good understanding of the practical requirements. Examples of this were given for centrifugal separators (9), as well as for back pressure steam turbines (15).

* Presented at the Malaysian International Symposium on Palm Oil Processing and Marketing, Kuala Lumpur, June 1976.

Effluent and other waste disposal and utilization

Various solutions have been proposed to solve the increasing problem of palm oil mill waste disposal.

The treatments included flotation, evaporation, drying and biological treatment using high rate bio-filtration (16). Feeding trials on cattle and sheep (39, 13) were encouraging. The nutritional value can be further upgraded by fermentation techniques.

Effluent treatment and disposal is not cheap and also requires skill and careful examination of the waste producing processes (16). Which process is chosen and whether other outlets such as e.g. manufacturing of paper pulp (28) is viable, is ultimately a question of economics.

It is certain, however, that the pollution problem must be given priority consideration and not only for oil mill wastes but also for refinery effluents.

Quality

Present day raw material availability, marketing exigencies and customers' more stringent requirements for quality consistency have pushed ahead the development of oil and fat processing technology and brought about a substantial increase of flexibility in the utilization of raw material. Furthermore, the capacities of refining and processing units have increased. By retro-action, the requirements for high standard quality and consistency have also been upgraded.

The Malaysian palm oil industry is certainly aware of this and constant efforts are made to achieve and maintain good quality standards, not only by continuous control of the oil in the various laboratories linked to the bulking installations, but also by improving the production conditions thanks to better knowledge of the parameters which influence the quality (4, 6, 12, 19). One of the primary tasks is quality assessment itself. It has been shown clearly that systematic quality control has a direct impact on the improvement of quality (12). Various international efforts are being made to assess the characteristics of palm oil and it is noteworthy that Malaysia is a leading example for all palm oil producing countries, since quality control is carried out with standardized tests adopted practically throughout the country. These controls are made for exported oils and direct links exist between the producer and overseas consumers. It is hoped that the constant effort in this field will be maintained but this can only be achieved if close co-operation between producer, consumer and quality testing bodies exists (4, 12, 23).

It is noteworthy that the assessment of quality is more reliable when different tests are taken in context one with the other (4, 12, 19, 23).

The influence of milling conditions on the quality of palm oil has already been investigated thoroughly and, in fact, gave ample subject for a whole symposium (18). However, there is always space for practical improvements and it was shown (41) that the degree of iron contamination can be limited by strict control of the purifier efficiency.

In view of the long time interval between production and refining of palm oil if shipped overseas, it is evidently desirable to reduce any pro-oxidant contaminant to a minimum (4, 19, 23). With regard to treatments with anti-oxidants, it was shown that crude palm oil responds well to tertiary butyl hydroquinone (TBHQ), especially in combination with citric acid. However, its use is not generally authorized in edible oils.

The need for careful handling of palm oil during storage and transport cannot be overstressed. Low temperature compatible with the avoidance of segregation due to partial solidification, gas blanketing and exclusion of contamination by thorough cleaning and good tank lining are recommended (4, 30). Pigging of lines exists in some terminals (42).

Practical experience has shown that it is possible to ship palm oil with ffa content below 2% and total oxidation value of less than 6 with only a moderate increment during transport (4). The areas where there can be a detrimental effect on palm oil include shipping, storage, tankers, pipelines, and the several trans-loadings (up to 8 for palm oil shipped to an overseas refinery). These enumerations are confined to the oil outside the mill and refinery, but they stress the imperative need for constant control (9).

The reduction of risks of human error is desirable. Automatic control temperature charts for tanks and flowmeters recording densities versus temperatures should be considered.

A fundamental approach to the better understanding of oxidation was made by a systematic study of reactions of pure fatty acids, mono- and triglycerides with carotene (40).

The pro-oxidant effect of carotene in the absence of anti-oxidants such as tocopherols (26, 38) was re-established.

If this line of investigation is extended to other components of palm oil liable to influence the oxidation behaviour, such as tocopherols and tocotrienols, it would help the producers and processors of palm oil to get a better understanding and better knowledge of the relevant parameters and would finally supersede empirical actions; e.g. the precise inter-relation between natural and artificial anti-oxidants, synergists and chelating agents needs further elucidation.

Transport

The dramatic increase in palm oil output, the diversification of the shipped products, the split-up at destinations, as well

as the higher exigencies for quality, have induced the storage operators and shipowners to re-consider completely the problem of bulk shipment of palm oil (5, 32). There will always exist a balance between more or less sophisticated cargoes, but the final decision is a matter of costs. Separate parcels per individual buyer, stainless steel tanks (especially for fatty acids), gas blanketing, have all been advocated and sometimes put into practice. Apart from such basic principles as thorough training of the persons in charge, tank coatings in good condition and rigid heating instructions, a dialogue between the producer and the marketer of oil with the shipowner and storage operator should permit them to find the most suitable solutions.

Refining (3)

Refining of palm oil is by now a well established practice. Over one and a half million tons palm oil have been imported in 1975 into industrialised countries and used primarily for edible purposes. Malaysia itself is processing one quarter of its own production (5, 29), ranging from neutralisation and fractionation to packed products. Conventional refining comprises degumming – deacidification – bleaching – deodorisation. Different alternatives are possible according to the final requirements, and these, together with the practical experience obtained, were discussed (5).

Thus, physical refining will reduce the refining losses, but is slightly more demanding on the quality of the crude oil than alkali refining of palm oil (2, 9). Earth bleaching and alkali refining is preferred by some refiners whenever a high residual tocopherol content is desirable (5). The final suitability of the refined palm oil for its end-uses can be further improved by hydrogenation, fractionation and transesterification.

Again, as for palm oil production, the collaboration between the equipment manufacturer and the utiliser is manifest; be it for the installation of unit operation equipment, such as separators (9), or for the set-up (2) and operation (5) of complete refineries.

The Malaysian refiner is in a better position to obtain good quality products than is his overseas counterpart. This is not only because the raw material is fresher, but primarily because he can and should exert an immediate influence on the producer for high standard quality of the crude oil. The experience which is being gained today (5) could be used optimally in this respect.

Much more practical experience is necessary to assess the influence of transport on semi-refined and refined palm oil (9, 23, 21). A rule of thumb is that fully refined oil travels better than crude, which itself travels better than neutralized, and this in turn better than neutralized bleached oil. But this is true only under optimum conditions and re-refining of any oil is definitely a set-back for stability in the end product.

It stands to reason that the care in handling semi-refined and refined products, and their quality control, must be even more strict than for crude oil if they are to maintain competitive levels with other edible oils and fats on the world market.

Fractionation

The Malaysian industry is today well acquainted with fractionation of palm oil. This is carried out by batch crystallization or continuous crystallization.

Thus 'dry fractionation', that is crystallization of the oil as such under controlled conditions, is a batch process. The crystals are removed by continuous filtration over a belt filter (5), or a drum filter (2). In the 'Lanza' process, the segregation of the solid and liquid phases is performed by washing the crystals with an aqueous detergent (8) and subsequent separation by centrifugation. The surface active agent can either be a chemical detergent, such as sodium lauryl sulphate, or soap obtained by partly neutralising the oil with alkali. In 'wet fractionation', that is fractionation in the presence of solvent (e.g. hexane: 7), the oil, after continuous crystallization, is fractionated on a continuous drum filter. Fractionation combined with transesterification lowers substantially the crystallization temperature (8). In the field of research and development, the application of density gradients to facilitate the separation of olein and stearin phases without filtration have shown very encouraging results (29).

While ample experience has been acquired by now for the engineering aspect of fractional crystallization (1, 5, 7, 8), and also of the average characteristics of the fractions obtained (5, 8), investigations on the quality of palm oil as to its effect on crystallization and fractionation, have only just started (20, 21). However, some basic facts seem to emerge. Crystallization processes are extremely intricate phenomena. Apart from the ambient conditions, they are influenced by the presence of free fatty acids, partial glycerides and also by oxidation. This holds equally for 'dry' as well as for 'wet' fractionation (27). Both for yield and sharp fractionation, that is good separation of olein from stearin phase, SPB quality palm oil seems the ideal raw material.

With regard to transport of crude fractionated as well as semi-refined and refined fractions, further experience must be gained. However, crude olein seems to travel well, provided due precautions in initial production and handling have been taken (3, 16).

End uses (3, 6, 29, 34)

Palm oil is a general purpose oil and as such is used almost entirely as an ingredient by the food manufacturer.

The choice will be governed by three criteria.

- Is the price advantageous?
- Has the oil got the technical properties required for the products and processes in which it is to be used?
- Is the product of consistently reliable quality?

The main food uses of fats are

- margarine
- shortenings for domestic and manufacturing uses
- frying fats
- salad oil
- fats for specialized food manufacture, such as confectionery, ice cream, imitation cream.

Each product has well established specifications (6, 23) and the amount of palm oil as an ingredient depends on its quality and on its suitability to match these.

Palm oil is extensively used in biscuit manufacture as a dough fat, either as straight palm or blended with hydrogenated palm or other fat. It is also used in margarine and ice cream manufacture. Olein is being used straight, blended or hydrogenated. With slip melting point 17°C and a dilatation at 20°C of 180-200 it is suitable for use in margarine, especially in view of its enhanced keepability. It can even replace some lauric fats in margarine. Blended with hydrogenated oil, it is used as a wafer filling fat in biscuit manufacture.

The potato crisp industry has become a major user of palm olein, which has in some instances substituted groundnut oil. When double fractionated, it can be used for mayonnaise.

Interesterified palm oil is largely used in margarine, and partly hydrogenated and/or fractionated palm oil is used for vanaspati. The solid fraction, preferably after double fractionation, is a valuable raw material for palmitic acid. The stearin fraction is also used for the manufacture of hard soaps blended with lauric fats. The mid-fraction, after acetone fractionation, can be used as cocoa butter substitute.

This lengthy but certainly not complete list of possible uses shows the wide possible applications.

It should however not be forgotten that the modern oil and fat refining and processing industry can use almost every type of oil and fat for any desired end product, at least, if blended with other fats. The flexibility of modern technology is very great but adjustment of raw material within the factory to the desirable characteristics of the end product is becoming more difficult as the total capacity of the installation becomes larger. This is certainly the present day tendency.

Hence, the precise knowledge of the characteristics, and their consistency, as well as regularity in supply of the incoming product, be it crude, semi-refined, fractionated or fully refined palm oil, is becoming an ever-increasing necessity.

Evidently, once the consumer has switched to another product, re-adjustment becomes increasingly difficult.

Marketing

Four papers dealt with marketing development and trends (1, 24, 35, 36). After a historical survey of the development and marketing of Malaysian palm oil (1) it was shown how the increased flow of Malaysian oil seeks its place in competition with the other most important vegetable oils and fats (36). It is worth while to note that in 1973/1974, the increased availability of palm oil coincided with a restricted supply of soyabean oil. This resulted in a price advantage on account of which the traditional US soyabean oil users were forced to discover the virtues of palm oil.

The need to consider selling palm oil on concessionary conditions was pointed out (36).

The complexity of competition and fluctuation in price make price stabilization schemes for producers very difficult and it was recommended in the best interest of the country to remain clear of any international control schemes (24, 36). Considerations on the values, functions and operations of a commodity exchange were in favour of a self regulation to ensure the relative stability of future markets (35).

Future work

Re-reading Dr Turner's recommendations made in 1969 (18) for future work, I see little to add. I notice that the Malaysian oil palm industry has basically followed his advice and that development is carried out on a large and enthusiastic basis. Valuable efforts have been made and there are results to show. Perhaps a better co-ordination of efforts would have yielded more practical results profitable for overall application. Thus, some priorities of research and investigations could be selected and supported by the industry as a whole.

The need for development work in Malaysia is certainly considerable.

In the preceding, no attempt was made to distinguish between work done in Malaysia and in other countries. Product and quality research can be and is carried out in industrialized countries. However, consumption research

has now entirely new aspects, such as optimization of the processes as well as maximum adjustment to the consumers demands and it is up to the Malaysian palm oil producers and processors to improve knowledge in this field.

Literature

(1) Allott, D H N, Ivan, C H and Wong (1976) 'Evolution of palm oil marketing from Malaysia', International Symposium.

(2) Athanassiadis, A, (1976), 'Refining and segregation of palm oil', International Symposium.

(3) Baltes, J, (1975) DAS 1767675, Harburger Olwerke, Brinckmann & Mergell, Hamburg. 'Technologien zur Verarbeitung von Palmol und dessen Verwendung'. *Fette Seifen Anstrichmittel,* 77, 41-50.

(4) Bek-Nielsen, B, (1976) 'Quality preservation and testing of Malaysian palm oil from fresh fruit bunches to the oil refinery', International Symposium.

(5) Bek-Nielsen, B, and Krishnan, S, (1976) 'Refining and fractionation of palm oil', International Symposium.

(6) Berger, K G, (1976) 'Technical requirements for marketing palm oil in the food industry', International Symposium.

(7) Bernardini, M, (1976) 'Continuous solvent fractionation of palm oil and direct solvent extraction of palm kernel', International Symposium.

(8) Braae, B, (1976) 'Refining and fractionation of palm oil', International Symposium.

(9) Breuing, K H, (1976) 'Separation practice and its application to the extraction and alkali refining of palm oil', International Symposium.

(10) Chan Khoon San, (1976) 'Sampling of oil palm bunch stalk refuse to determine oil loss', International Symposium.

(11) Chin, A H G, and Tan Boon Keng, (1976) 'The quality of solvent-extracted palm oil', International Symposium.

(12) Cornelius, J A, (1976) 'Progress towards international standards for crude palm oil', International Symposium.

(13) Devendra, C, and Muthurajah, R N, (1976) 'The utilization of palm oil by-products by sheep', International Symposium.

(14) Everaerts, P J, (1976) 'Extraction of palm oil with a solvent', *Oleagineux,* 31, (3) 129-130.

(15) Hayes, C W, (1976) 'Steam turbine alternator sets for the palm oil industry', International Symposium.

(16) Hemming, M L, (1976) 'The treatment of Effluents from the production of palm oil', International Symposium.

(17) Huffaker, J E, (1976) 'Tertiary Butylhydroquinone in palm oil; a method of analysis', International Symposium.

(18) Incorporated Society of Planters Symposium, (1969) 'Quality and marketing of oil palm products'.

(19) Jacobsberg, B, (1975) 'Characteristics of Malaysian palm oil', *Oleagineux* 30, 271-276, 319-324.

(20) Jacobsberg, B, Oh Chuan Ho, (1976) 'Studies in palm oil crystallization', *J Amer. Oil Chem. Soc.* (in press).

(21) Jacobsberg, B, Jacqmain, D, (1976) 'Palm oil fractionation as related to the crystallization properties of triglycerides', (1976) International Symposium.

(22) Jacqmain, D, (1976) 'Theoretical considerations on sampling', MARDI Workshop on oil palm technology, Kuala Lumpur.

(23) Lim, K H, and Whiting, D A M, (1976), 'The use of a mechanical rotary cutter to obtain homogenized samples of solid oil palm products', International Symposium.

(24) Lim, K H, and Whiting, D A M, (1976), 'The influence of the non-Newtonian behaviour of crude palm oil on the design of clarifications station equipment', International Symposium.

(25) Loncin, M, (1974), 'Can today's milling process for palm oil be improved' MARDI Workshop on oil palm technology, Kuala Lumpur.

(26) Loncin, M, and Jacobsberg, B, (1964) 'Die gleichzeitige Oxydation von Tocopherol und Carotin durch Luftsauerstoff in Anwesenheit von gesattigten und ungesattigten Fettsaureestern', *Fette Seifen Anstrichmittel,* 66, 910-912.

(27) Loposso, U, (1976) 'Fractionnement et cristallisation des corps gras en presence de solvents, Memoire de fin d'etudes, Institut des Industries de Fermentation-Institut Meurice-Chimie, CERIA-Brussels.

(28) Maycock, J H, (1975) 'The developments in palm oil factory design since the early 1900's', *Planter,* 51, 335-354.

(29) Moolayil, J, (1976) 'Uses of palm oil', International Symposium.

(30) Muthurajah, R N, Peh Teik Bin (1976) 'Manufacture of paper pulps from empty bunch waste', International Symposium.

(31) Ong, S H, Chuah, C C and Boey, P L, (1976) 'Preliminary study on olein-stearin separation of palm oil', International Symposium.

(32) Roger, B S, (1976) 'Bulk shipping and storage of palm oil and its derivatives-the shipowner's and storage operator's viewpoint', International Symposium.

(33) Southworth, A, (1976) 'Process Control', International Symposium.

(97818)

(34) Taylor, A M, (1976) 'Crystallization and dry fractionation of Malaysian palm oil', *Oleagineux* 31. (2) 73-79.

(35) Takahashi, H, (1976) 'Commodity futures trading and its role in business management', International Symposium.

(36) Tan Bock Thiam, (1976) 'Trade prospects for Malaysian palm oil', International Symposium.

(37) Velayuthan, A, (1975) 'Palm oil process control', *Planter*, 51, 386-402.

(38) Weir, G, (1974) 'Carotene and palm quality', Palm Oil Symposium, Society for Chemical Industry, Oils and Fats Group, London.

(39) Webb, B H, Hutagalung, R I, and Cheam, S T, (1976) 'Palm Oil Mill Waste as animal feed-processing and utilization', International Symposium.

(40) Wong, K C, (1976) 'Oxidation of some of the components of palm oil', International Symposium.

(41) Yeoh, G H, (1976) 'A study of the nature and effects of iron contamination in palm oil' International Symposium.

(42) Yong, M L, (1976) 'The installation and operation of pigging systems in palm oil export terminals', International Symposium.

Progress towards International Standards for Crude Palm Oil*

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Summary

Crude palm oil for edible purposes has for many years been sold on the basis of moisture, dirt and free fatty acid (ffa) content. With an increasingly competitive market, user requirements with regard to quality characteristics are becoming more closely defined; thus enabling the producer to market an oil which can be refined to particular standards of colour, taste, consistency and shelf-life at minimum cost to the refiner.

Other tests for palm oil quality have been developed for use over the last 20 years by various organisations. These tests include assessment of bleachability, oxidation and oxidative stability. With the possibility of oils with a higher unsaturated acid content from African-American hybrid palms being produced commercially in the future, fatty acid composition may become a more important quality factor.

The Vegetable Oils Technical Committee of the Rubber Growers' Association, at the request of the Malaysian Oil Palm Growers' Council, has made considerable progress in testing and drafting suitable procedures in liaison with the Oils and Fats Section of the International Union of Pure and Applied Chemistry, the International Standards Organisation, the Codex Alimentarius and the International Association of Seed Crushers but limits for the additional characteristics and properties for the various qualities of palm oil marketed now or in the future have yet to be agreed upon.

Introduction

Palm oil accounts for an increasing proportion of the total commercial edible vegetable oil and vegetable oil equivalent exports from primary countries, amounting to 16.9 per cent in 1974 (Anon, 1975). Hence there is a pressing need to extend the outlets in a competitive market and it is becoming realised that quality characteristics of the crude oil need to be more closely defined in order that the producer can provide a product which can be processed to particular standards of colour, taste, consistency and shelf life at minimum cost. Crude palm oil for edible purposes has for many years been sold on the basis of moisture, dirt and free fatty acid (ffa) content.

In Nigeria, where most of the palm oil still comes from small producers, early export supplies were usually 'soft oil', so-called because the greater part of the oil was liquid at tropical temperatures; its average ffa was about 7 to 12 per cent. 'Hard oil', on the other hand, was prepared under conditions in which considerably more hydrolysis took place, the oil becoming solid at tropical temperatures with an ffa usually between 30 and 50 per cent (Hartley, 1967).

By 1949 when the Nigerian Produce Marketing Board was first set up, there were five prescribed grades of palm oil for export available, namely grade I, under 9 per cent; grade II, 9 to 18 per cent; grade III, 18 to 27 per cent; grade IV, 27 to 36 per cent and grade V, over 36 per cent ffa. With price incentives for the producer of low ffa oils and the introduction of a further grade by the Marketing Board in 1950 with an ffa not exceeding 4.5 per cent called Special Grade Palm Oil (SPO), the quality even for small producers soon improved dramatically. In 1955 this grade was split in two to give SPO 'A' with ffa not exceeding 3.5 per cent and SPO 'B' with ffa between 3.5 and 4.5 per cent. By the following year 3.5 per cent ffa became the limit for all SPO oil, and oil between 3.5 and 9 per cent ffa was called Technical Palm Oil (TPO). All grades had a legal maximum limit of 2 per cent foreign matter plus water as received at the buying stations although, in practice, the moisture content was usually between 0.5 and 1.0 per cent (Coursey, 1960). Whereas in 1950, only about 0.2 per cent of the total palm oil purchased by the Board was of that category, by 1965, over 80 per cent of the total purchases of oil from small producers was of SPO grade, by which time, as indicated above, the ffa limit was 3.5 per cent. The oil was sold overseas on an arrival basis of 5% ffa (Iwuchukwu, 1965). However, the standards laid down did not prevent:

(a) Illegal adulteration of the product between production and export. This was done in order to reduce the ffa content of inferior grade oils and ingenious methods were sometimes used. Washing soda, chalk and lime were often used as the alkali and the resulting soap subsequently removed as insoluble aluminium soaps by double decomposition with alum. Battery acid was sometimes used to neutralise excess alkali (Coursey, personal communication).

(b) High iron pick-up from machinery, pipes and containers.

(c) Blending high quality low ffa oils with lower quality high ffa oils.

*Paper presented at the Malaysian International Symposium on Palm Oil Processing and Marketing, Kuala Lumpur, June 1976.

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There is evidence that the latter practice is much more widespread than in the context of West African trade and while the ffa of such blended oils is in direct relationship to the ffa's of the separate oils and may be within the grade limits, other vital properties, such as bleachability and stability, can be seriously impared and inferior to normal unblended oils of equivalent ffa. More stringent specifications for a grade of palm oil from plantations in Zaire called Special Prime Bleachable (SPB) oil which appeared on the market at least as far back as the early 1960's, resulted in marketing an oil of around 2 per cent ffa with other desirable properties which have since been aimed at by producers in other parts of the palm oil producing world, particularly Malaysia.

Table 1 shows a comparison between SPB and regular grade palm oil from Zaire plantations.

Table 1 Comparison between SPB and Regular Grade Palm Oil from Zaire Plantations (from Loncin *et al.*, 1970)

	Regular Grade	SPB Grade
Free Fatty Acid (as palmitic) %	3 - 5	1 - 2.5
Moisture, %	0.1	0.1
Impurities, %	0.01	0.002
Iron, ppm	10	av. 5
Copper, ppm	0.2	av. 0.2
Iodine Value	45 - 56	53 ± 1.5
Carotene, ppm	500 - 700	approx. 500
Tocopherol, ppm	400 - 600	approx. 800
Bleachability, Lovibond units, 5¼" cell		
Red	3.5	2.0
Yellow	35	20

Bleaching tests

Refiners wish to know how the crude oil will behave on processing and various bleaching tests have been developed over the years. These include:

(a) bleaching tests on the crude oils

(i) using earth

(ii) using heat in the absence of air

(iii) using a combination of heat plus earth.

(b) bleaching tests on the neutralised oils.

All these bleaching tests involve an assessment of the colour of the oils after bleaching under standardised conditions and the results can be expressed in terms either of residual colour or of the proportion of the colour removed.

If oils of good and of poor bleachability are to be segregated at source, a simple sorting test is required and only methods (a) (i) and (a) (ii) are really amenable to this. The acceptance of any particular bleaching test by refiners as a whole has met with resistance since different refiners use different bleaching methods and meaningful results are more likely to be achieved when the laboratory tests are akin to the large-scale process. However the International Association of Seed Crushers (IASC) have recently accepted a bleachability test similar to one evolved at the Tropical Products Institute in the 1950's but carried out at a higher temperature. The proposed test uses 5 per cent by mass of Tonsil Standard FF bleaching earth of German origin stirred with 200 g oil at 150°C for 1 hour, the colour of the hot filtered oil being measured in a Lovibond tintometer (Hoffmann *et al.*, 1975). This method is now also under consideration for publication as a British Standard.

The present method of colour assessment, which is used virtually universally in the trade, involves visually comparing the colour of the melted oil in a glass cell of standard path length with a combination of standard Lovibond red, yellow and blue slides. However, this subjective method can give widely differing results with different operators. Using a Lovibond tintometer with standard slides made up of 2 known combinations of red, yellow and blue units, giving colours typical of bleached palm oil, out of 9 operators in a single laboratory, only 1 provided a correct answer in both cases.

Table 2 Lovibond Tintometer Readings for Standard Slides

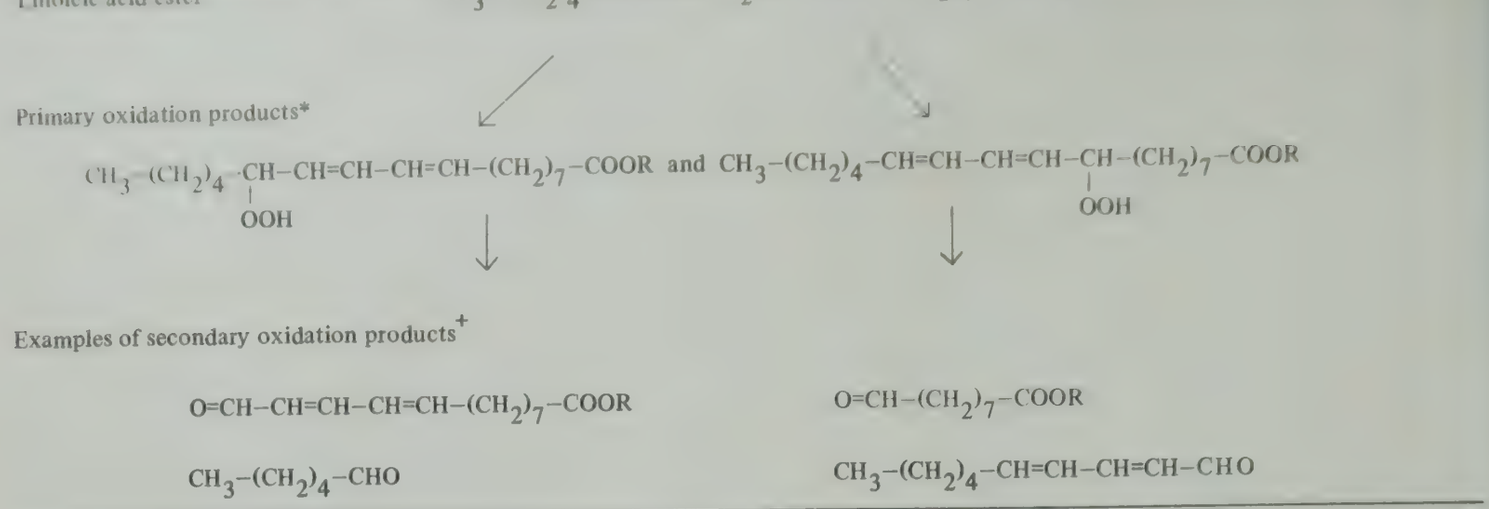
Operator	Slide 1			Slide 2		
	Red	Yellow	Blue	Red	Yellow	Blue
A	0.3	2.3	0.2	3	31	1.3
B	0.7	2.5	1.1	4	40	1.5
C	1.0	3.3	1.0	4	40	1.3
D	1.0	3.2	1.3	4	20	1.9
E	0.9	3.2	1.6	4	22	2.0
F	0.0	2.8	0.1	4	44	1.2
G	1.2	3.4	1.4	5	20	2.0
H	0.9	2.8	0.9	3	59	0.3
I	1.0	3.1	1.3	4	21	1.8
Actual Colours	0.3	2.2	0.2	3	28	0.4

It is clear from this and similar collaborative tests that considerable errors of colour measurement can be introduced by the operator and that for the satisfactory assessment of the results from bleaching tests a less subjective method of colour assessment is highly desirable.

The assessment of oxidation

The ease of bleaching and general acceptability of an oil to the refiner is basically dependent upon the degree and type of oxidation which has taken place. The autoxidation of lipids in general, and palm oil in particular, can take place in several possible ways and can produce a number of oxidation products; consequently the assessment of degree of oxidation is difficult and no single method can give anything like a complete picture. It is the unsaturated fatty acid part of the palm oil glycerides which are more particularly susceptible to oxidation, particularly the linoleic acid, which is present to the extent of up to about

Figure 1 The Autoxidation of Linoleic Acid Ester



* Determined by, e.g. peroxide value or absorption @ ca 233 nm

\+ Determined by, e.g. p-anisidine value or absorption @ ca 269 nm

12 per cent of the total fatty acids. Figure 1 indicates paths of autoxidation of linoleic acid ester to produce primary oxidation products including particularly hydroperoxides with the double bonds conjugated. Hydroperoxides are unstable and, under the influence of heat, fairly readily break down into secondary oxidation products comprising aldehydes and ketones which give rise to undesirable off-flavours to the product if they cannot be completely removed on refining.

The degree and type of oxidation in practice depends on the history of the oil. For example, the oil may be the product of blending good and poor quality oils at the producing end, or it may have been otherwise maltreated before reaching the producer so that it has a high content of iron or copper through the action of the ffa present in the oil on machinery, pipelines, containers etc. The natural antioxidants may have been degraded in consequence, or alternatively by overheating. Thus the oil may be either already oxidised or its susceptibility to oxidation greatly increased and therefore the shelf-life of the products made from it are likely to have decreased. Consequently, a considerable amount of attention has been given in recent years to tests for:

(a) the extent and nature of oxidation by the assay of primary and secondary oxidation products and;

(b) the susceptibility to oxidation by the Active Oxygen Method (AOM) Stability and by pro-and anti-oxidant level tests.

Collaborative work

In 1969, the Malaysian Oil Palm Grower's Council (OPGC) requested the Rubber Growers' Association to assist in the establishment of a Standard Malaysian Palm Oil which will be marketed to comply with certain pre-determined specifications. As a first step, the Vegetable Oils Technical Committee (VOTC) was set up, comprising representatives of producers and consumers along with independent bodies, such as TPI, to ascertain:

(a) the properties of palm oil for which measurements are desirable and;

(b) the methods to be used for measuring these properties.

As a result of circulated questionnaires and inter-laboratory tests, considerable progress in the drawing up of standard methods of analysis particularly applicable to palm oil have been made. The Committee have standardised texts of methods for the determination of acidity, volatile matter and insoluble impurities and are currently reviewing methods for several other tests which are of interest to the palm oil trade. These include carotene content, peroxide value, p-anisidine value, tocopherol content, bleachability, copper and iron contents.

Around the time that the VOTC became active in this field a Palm Oil Working Group was set up within the Oils and Fats Section of the International Union of Pure and Applied Chemistry (IUPAC) which carried out a number of collaborative bleaching tests using various suggested procedures together with ffa, copper, iron, carotene and oxidation determinations. After 2 years' work the group considered that until more is known about the compounds which resist bleaching, the assessment of primary and secondary oxidation products would be more informative with regard to oil quality. Hence work in 1972 concentrated on the collaborative assessment of primary oxidation products by peroxide value and the secondary oxidation products by the p-anisidine value.

Table 3 Results of Collaborative Tests on Crude Palm Oil by IUPAC Oils and Fats Section Palm Oil Working Group 1972

Sample No		1	2	3	4	5	6
FFA (palmitic acid) %	a	4.7–5.2	4.8–5.3	2.0–2.2	2.1–2.4	2.0–2.6	2.2–2.9
	b	5.0	5.1	2.1	2.3	2.1	2.4
Carotene, mg/kg	a	26.6–36	65–105	520–704	456–592	175–207	121–160
	b	29.9	91.5	607	480	197	141
Peroxide value, meq/kg	a	6.7–13.5	9.7–15.1	0–8.8	5.5–18.3	0.1–2.9	0–5.9
	b	9.6	11.9	3.5	13.8	0.65	2.2
p-Anisidine value	a	32.0–39.4	24.6–34.9	1.4–4.3	2.8–5.9	3.6–9.5	20.2–28.1
	b	35.4	28.2	2.8	4.4	7.0	24.8
Totox value (2PV+pAV)	b	54.6	52.0	9.8	32.0	8.3	29.2
Copper, mg/kg	a	0.05–0.3	0.07–0.3	0.02–0.2	0.03–0.2	0.02–0.4	0.04–0.2
	b	0.14	0.16	0.12	0.08	0.11	0.08
Iron, mg/kg	a	53–107	67–135	1.5–3.6	1.0–3.6	1.5–3.5	1.1–3.4
	b	70	85	2.5	2.1	2.4	2.2

a Spread between 8 and 13 laboratories.

b Mean

Samples 1, 5 and 6 were derived from samples 2, 3 and 4 respectively by heating under vacuum.

Peroxide values are a measure of the quantity of hydroperoxides present and are expressed in milli-equivalents of oxygen per kg of oil. The p-anisidine value measures mainly the amount of alpha-beta-unsaturated aldehydes (2-alkenals) present in the oils. The method is based on the fact that in the presence of acetic acid, p-anisidine reacts with aldehydic compounds in an oil producing yellowish reaction products. The colour intensity depends not only upon the amount of aldehydic compounds present but also on their structure. Thus, it has been found that a double bond in the carbon chain conjugated to the carbonyl double bond enhances the molar absorbance at 350 nm by a factor of 4 to 5. The results of collaborative tests during 1972 on 6 crude palm oil samples showed relatively good agreement for p-anisidine values (see table 3), taking into account the unfamiliarity of the analysis. With more stringent measures to exclude water from the acetic acid reagent, which has since been inserted into the text of the draft method, this agreement should be considerably improved. A standard deviation of 0.107 had been obtained in the tests by operators in the same laboratory and of 0.183 between different laboratories. Peroxide values tended to be in poor agreement, especially with samples having a low peroxide value and we suspect that this was due to insufficient care in sampling, since the peroxide value can so easily change on melting the oil to draw the sample for analysis. Suitable precautions have again been written into the draft specifications for peroxide value determination. The results of collaborative testing emphasize the need for adequate attention to detail in specifying standard methods for carrying out the tests, and are a justification for the production of standard methods particularly for the testing of palm oil rather than merely following methods which are generally applicable to crude edible oils. It has been suggested that the best overall assessment of oxidation in oils and fats is given by the 'Totox' value which is defined as:

Totox value = (2 x peroxide value) + p-anisidine value. Correlation also exists between totox value and conjugated diene and triene values, the relationship being:

$$\text{Totox value} = 100\,(a_{235} - a_{270})$$

where a_{235} and a_{270} are the specific absorbances of the oil at 235 and 270nm respectively.

In the opinion of the Swedish collaborator who put forward the draft text of the p-anisidine test, a crude palm oil with a totox value of less than 10 units, such as sample 3, would refine well. Similarly sample 2 is a very poor oil and sample 4 is intermediate in quality.

Plasticity

Plasticity is an important factor in the margarine and shortening industry in which palm oil is used to an increasing extent. For palm oil, this has been shown by Loncin and Jacobsberg (1963) to depend on the proportion of diglycerides present which in turn are directly dependent on the ffa of the crude oil. The diglycerides form an eutectic with the triglycerides and an oil with minimum hardness results from the diglycerides present when the ffa of the crude oil is about 7 per cent. These characteristics persist in the refined oil since the diglycerides remain although the ffa is removed. Thus, a refined palm oil originating from 5 per cent ffa crude oil has a spreading threshold which is 5°C lower than for oil from 2 per cent ffa crude.

In addition to the proportion of partial glycerides, the degree of unsaturation of the glycerides and their fatty acid arrangement also affect plasticity. Over 85 per cent of the unsaturated fatty acid chains are located on the central ester bond of the glycerol radical, resulting in the oil being semi-solid at normal room temperatures. This property and the melting range permit its use as a major

component in margarine and shortening blends without hydrogenation. (Loncin *et al*, 1970). The degree of unsaturation of palm oil appears to depend to a large extent on climatic conditions (IRHO, 1956). However, there are possibilities of modifying the amount of unsaturation in palm oil by breeding as well as by fractionation techniques. For example, the palm oil from hybrids between the West African (*Elaeis guineensis*) and the South American (*E. oleifera*) oil palms, has an unsaturation which is markedly higher than ordinary palm oil, being intermediate between that of the oils of the two species (Table 4). These hybrids are being grown experimentally in various parts of West Africa and the Far East, and commercially on a small scale in South and Central America.

Table 4 Component Fatty Acids, Iodine Values and Melting Points of Mesocarp Oils from Hybrid Palms and the parent species (from Macfarlane *et al.*, 1975 & Cornelius, 1975)

Component fatty acid, %	*Elaeis guineensis*	Hybrid	*Elaeis Oleifera*
Saturated			
Myristic	2.0	0.7	trace
Palmitic	46.8	32.1	22.9
Stearic	4.8	3.7	1.0
Unsaturated			
Palmitoleic	-	-	1.3
Oleic	34.6	51.0	54.8
Linoleic	11.8	12.8	20.0
Iodine value (Wijs, ½ hour)	47.0	63.5	78.5
Melting point, ^{o}C	38–45	24–34	13–14

Macfarlane *et al ., J. Sci. Fd Agric.*, 1975, *26*, 1293–1298

Cornelius, *Oil Palm News*, 1975, (19), 12–13

Unsaturation is usually assessed by iodine value determinations or by determining the proportions of component fatty acids by gas liquid chromatography (GLC) and plasticity by melting point, solid fat index (dilatation) or wide-line NMR. Iodine values are well known to fat analysts and both national and international standard procedures are available which are applicable to palm oil. The American Oil Chemists' Society (1974) have published procedures for GLC of fatty acids (Ce 1-62) and solid fat index (Cd 10-57) and texts will be published in due course by the International Union of Pure and Applied Chemistry (IUPAC), the International Standards Organisation (ISO) and the British Standards Institution (BSI). Solid fat index is an empirical measure of the solid fat content calculated from the measurement of the specific volumes of the fat at various temperatures. Wide-line NMR provides a more direct measurement of solid fat content since the instrument gives a signal which is in proportion to the number of protons present in molecules existing in the liquid state.

Published standard methods for the assessment of unsaturation and plasticity which are specifically applicable to crude palm oil will clearly be needed in the future. Limits for these characteristics will depend upon user requirements.

It should be mentioned that in addition to the VOTC and IUPAC, various other international and national organisations are involved with the drawing up of standards for fat analysis which are applicable to palm oil. These include the International Standards Organisation (ISO), the International Association of Seed Crushers (IASC), which have already been referred to with regard to a standard bleaching test, the Codex Alimentarius and the British Standards Institution (BSI). However, with the considerable liaison between the various bodies concerned, it is anticipated, and certainly to be hoped, that a duplication of methods for one particular test will be avoided and that satisfactory internationally recognised standard tests for the palm oil industry will be evolved.

Present and future requirements

Internationally recognised grades of crude palm oil with specified limits for the various characteristics have yet to be evolved and, generally at the present time, the characteristics are the subject of negotiations between the buyer and vendor. Reference has already been made to SPO palm oil, which used to be exported from Nigeria, and SPB oil from Zaire; similarly palm oils of various specified qualities at the time of shipment are offered for sale by various producers in Malaysia and elsewhere. For edible purposes, the basic requirement is that crude palm oil should be capable of being processed into a bland, stable, edible product. In addition, although the product specifications for the various uses may differ somewhat as regards colour, in general terms, colours in the range of 5.0 red to less than 1.0 red Lovibond units (5¼ in. cell), are required. Ordinary grade Malaysian palm oil is traded on a contractual basis of 5 per cent ffa with an allowance for moisture and impurities.

Producers have been made aware that oils of high ffa lead to reduced capacity in the refinery and to increased refining costs, and crude oils of lower ffa content can be purchased at a premium from certain plantations. In recent years, with a renewed interest and activity in steam refining, by which both neutralisation and deodorisation can be carried out in a single step with lower refining losses, it is likely that there will be increasing demand for oils not only of low ffa but also of low total oxidation and good bleachability as such oils are said to respond well to the steam refining method of processing (Pritchard, 1975). Johansson (1975) has indicated, from the point of view of a Swedish refiner, the quality characteristics for crude palm oil with they expect at present and believe should be possible in the future. Table 5 indicates these characteristics together with what he considers to be possible

Table 5 Quality characteristics desired for Crude Palm Oil (from Johansson, 1975)

	As received by refiner		Reachable at production centre
	Present	Future	
Water	max. 0.5	max. 0.5	
ffa (as palmitic acid)%	max. 3	max. 2.5	1.5 – 2.5
p-Anisidine value	max. 6	max. 4	2 – 3.5
Peroxide value, meq/kg	max. 5	max. 4	0 – 2
Totox value	max. 15	max. 10	2 – 8
Iron, mg/kg	max. 5	max. 3.5	2 – 3.5
Copper, mg/kg	max. 0.08	max. 0.05	0.03 – 0.07
AOM-stability, h	min. 53	min. 60	60 – 75
Tocopherol, mg/kg			800 – 1,050
E1%, 1cm @ 235			70 – 100
E1%, 1cm @ 270			20 – 35

to reach at production centres with sufficient attention to harvesting, handling and processing to produce the crude oil.

Conclusion

In this survey of progress to date towards international standards for crude palm oil, it is impossible to give a comprehensive treatise on the history of the subject but I have endeavoured to provide an overall picture of what has led up to the present situation and to indicate aims for the future. It will be clear that much has still to be done in the proper formulation of tests which are acceptable to user and producer, to buyer and seller, and also in the evolution of recognised grades with predictable refining properties giving refined oils of acceptable quality and shelf life when incorporated in the final products. In order that the intended aims are achieved, liaison and co-operation is necessary not only between the various bodies concerned with quality testing and specifications but also between producer and user. It is to be hoped that such symposia as the present one will be the catalysts which stimulate the existing encouraging level of co-operation to continue and to extend so that crude palm oil may find the place in the world market for edible oils which it needs to find and which it deserves.

References

American Oil Chemists' Society. (1974). *Official and Tentative Methods.* Champaign, Illinois.

Anon, (1975). *Tropical Products Quarterly.* **16**, 144.

Cornelius, J.A. (1975). Palm Oil from Hybrid Palms, *Oil Palm News.* (19), 12–13.

Coursey, D.G. (1960). Importance des Microorganisms dans la lipolyse de l'huile de palme en cours du Stockage. *Oléagineux,* **15**, 623–630.

Hartley, C.W.S. (1967). *The Oil Palm* London: Longmans Green, 706 pp.

Hoffman, G., Nijzink, T. and Recourt, J.H. (1975). Quality Assessment of Crude Palm Oils by Direct Bleaching with Activated Bleaching Earth. *Rev française des Corps Grás.* **22**, 511–515.

I.H.R.O. (1956). Variation des Caractéristiques de certaines huiles de palme, *Ser. Sci.* Institut de Recherches pour les Huiles et Oléagineux, Paris *No. 9.*

Iwuchukwu, A.N. (1965), Influence of Marketing Boards System and preliminary purification on Nigerian Palm Oil for Exports, *The Oil Palm.* Papers presented at the Tropical Products Institute Conference, Tropical Products Institute, London, pages 73–78.

Johansson, G. (1975), Quality of Palm Oil, *Chemistry and Industry,* **21**, 902–910.

Loncin, M. and Jacobsberg, B. (1963). Studies on Congo Palm Oil, *J. Am. Oil Chem. Soc.,* **40**, 18, 19, 40, 45.

Loncin, M., Jacobsberg, B. and Evrard, G. (1970). *Palm Oil – a Major Tropical Product,* Tropical Products Sales s.a., Brussels, 28 pp.

Macfarlane, N., Swetman, A. and Cornelius, J.A. (1975). Analysis of Mesocarp and Kernel Oils from the American Oil Palm and F_1 Hybrids with the West African Oil Palm, *J. Sci. Fd Agric.* **26**, 1293–1298.

Pritchard, J.L.R. (1975). Refining of Palm Oil, *Oil Palm News.* (20), 5–13.

Table 3 Imports of palm kernels and oil and palm oil into the principal importing countries (thousand tonnes)

	1972		1973		1974		1975[p]	
Palm kernels and oil	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil
France	20	30	18	22	18	18	12	22
West Germany	24	22	34	17	58	34	42	17
Netherlands	227	2	122	18	149	24	95	45
United Kingdom	28	60	35	79	45	57	75	64
United States	-	44	-	46	-	66	-	74
Total	299	158	209	182	270	199	224	222
Total in oil equivalent[a]	299		280		326		327	
Of which kernels in oil equivalent[a]	(141)		(98)		(127)		(105)	
Palm oil								
France		43		57		56		50
West Germany		149		152		133		210
Italy		51		57		54		52
Netherlands		159		160		147		183
United Kingdom		208		244		223		206
Canada		30		20		16		55
India		1		52		53		20
Iraq[e]		69		71		120		110
Japan		54		100		115		108
United States		194		176		200		436
Total		958		1,089		1,117		1,430

[a] Converted at 47% oil content

[e] Estimated

[p] Partly estimated

One of the more significant developments in 1975 as regards trade in palm oil was that imports into the United States more than doubled to reach 436 thousand tonnes compared to the 200 thousand tonnes purchased in 1974. This aroused much debate in the United States about the effect these purchases were having on the market for domestically produced soya oil and action has been called for by soya bean interests; it has been suggested that palm oil imports be restricted in some way in future, if not by voluntary agreement then by imposing import duties and quotas, and that loan programmes which aid the expansion of palm oil production in the developing countries be curtailed. The Malaysian Government has responded by asking the United States Administration to recognize that expanded palm oil output not only benefits the producers in the developing countries who often have only limited alternatives to oil palm cultivation, but also represents a long term, reliable and relatively cheap source of food oil to consumers in the developed and developing world. No immediate action is likely to be taken by the United States Government in response to the lobbying by the soya industry as two reports by USDA, currently awaited, are not likely to be available for some months. The reports examine the question of the effects of palm oil imports on the cost of living and on soya beans and oil, and of the US policy of contributing to international loans to finance oil palm production in developing countries.

World palm kernel output again increased in 1975, but to a considerably smaller extent than in 1974, to reach a record 1.04 million tonnes or 486 thousand tonnes in oil equivalent terms, just over 3% above production in 1974. The larger combined output of kernels in Peninsular Malaysia and Sabah at 255 thousand tonnes accounted for much of this increase in total production, while moderate gains were also achieved in several of the other main producing countries, notably Indonesia, Sierra Leone and the Ivory Coast. In Nigeria and Zaire, by contrast, kernel output is thought to have declined somewhat in 1975. World palm kernel output in 1976 is forecast to increase once more to around 1.09 million tonnes or 510 thousand tonnes oil equivalent (or in the order of 5% over 1975), with the expansion of production in Malaysia, Indonesia and the Ivory Coast being particularly significant, while Nigerian purchases could recover somewhat and Zaire's output decline still further.

Exports of palm kernels from the major producing countries in 1975 fell to about 271 thousand tonnes or by 16% below the previous year, but sales of palm kernel oil maintained their steady growth, and at an estimated 224 thousand tonnes were 8% above those in the previous twelve months. Thus in oil equivalent terms the combined exports of palm kernels and oil, estimated at 351 thousand tonnes, declined marginally in 1975. Only the United Kingdom out of the main importing countries increased its purchases of both kernels and oil in 1975 and kernel imports in particular, at 75 thousand tonnes, were at their highest level for many years. The Netherlands, on the other hand, again bought considerably fewer palm kernels

in 1975 (95 thousand tonnes), but this reduction was offset by increased imports of palm kernel oil (45 thousand tonnes). This situation also obtained in France, while West Germany purchased both fewer kernels and less oil. The United States imports of palm kernel oil continued to expand in 1975.

Palm oil prices were trending downwards until January of this year when Malaysia palm oil stood at $350 per tonne. Since then prices have shown some moderate recovery and in mid-March palm oil stood at $371 per tonne although by the end of March the price slipped back to $356. Prices this year, moreover, have still been considerably below the 1975 average monthly price of just over $439 per tonne. The recovery in palm oil values in the past two months appears to be a consequence of the fears of the effects of drought in Malaysia, (the shortage of water has been reported to have cut back the Malaysian palm oil mills' activities by up to 10 per cent), a certain tightness of supply in near positions and, initially at least, palm oil prices were spurred by the rally in soya bean and oil prices in the New Year after they had sunk to 455 cents per bushel and 100 florins per quintal respectively in December. Soya bean prices did slip somewhat in March, but do seem to be maintaining their higher values to some extent with demand for soya beans improving, the relative tightness of supplies due to the holdings policy for beans by farmers in the United States and the expected 7-10% reduction in plantings in that country this season. The implications of this situation for palm oil are, however, not particularly favourable as the strengthening demand for soya beans is largely a reflection of the increased demand for protein meals as the economic recovery gets under way. According to the FAO Intergovernmental Group on Oilseeds, Oils and Fats, production of edible/soap fats and oils and of oil meal protein is forecast to increase sharply this year over last (although output is following the trend of the decade to 1974) but global consumption is unlikely to absorb current output. Further downward pressure on prices of oils is expected as a result, while protein prices may show some limited strength in coming months. Moreover, if any measures are taken in the United States which could affect export sales of palm oil to that country, palm oil prices would come under additional pressure. On the other hand, some uncertainty remains to as the effect of the drought in Malaysia on palm oil output during the remainder of this year and, although production is still expected to increase, the uncertainty may help to support palm oil prices to some degree.

Table 4 Mid-month prices of palm oil, palm kernels and palm kernel oil

	1974 Average	1975 Average	1975			1976			
			October	November	December	January	February	March	
								16th	31st
(£ per long ton, nearest forward shipment, cif UK ports, excluding duties)									
Palm kernels, Nigerian	204.10[b]	94.08	91.00	91.00	93.00	92.00	85.00	88.00	92.00
Palm oil, Malaysian 5%[e]	288.28[ac]	200.02[c]	198.00	188.00	182.00	175.00	184.00	196.00	189.00
(US $ per long ton, nearest forward shipment, cif Continent, excluding duties)									
Palm kernel oil, Malaysian	NA	389[d]	NA	350	345	347½	355	362½	362½
Palm oil, Malaysian[e]	666[b]	439[d]	405	382½	364	350	370	371	356
Palm oil, Sumatran/Malaysian, re-sale (spot)	722	434	450	430	415	375	395	415	390

[a] per long ton
[b] Average of 9 months
[c] Average of 11 months
[d] Average of 8 months
[e] per tonne
NA Not Available

(97818)

Despite some limited recovery in the second half of the year, palm kernel and oil prices were generally very weak during 1975. This was on account of the abundant supply situation for lauric oils caused by the record copra and coconut oil production and exports of the Philippines. Although lauric oil supplies may increase by up to 5 per cent this year to some 3.6 million tonnes, nevertheless an apparent shortage of near supplies and improved consumer demand led to some improvement in lauric oil price levels in the first three months of 1976. However, the present supply outlook appears to preclude the possibility of further significant or sustained price rises for lauric items, and therefore the outlook for palm kernels and oil seems to be for a continuation of present low prices in the foreseeable future.

P S (August 1976)

Since this market survey was compiled early in April there has been a marked recovery in the world oils and fats market. A sharp rise in prices took place between May and July against a background of anxiety about the adequacy of soya bean and meal supplies in 1976-77 in the face of intensified demand from consumers, including a substantial purchase of beans by the Soviet Union. The expected smaller 1976 United States soya bean harvest was officially confirmed in the August crop estimate of 36.6 million tonnes, 12 per cent down. While the concern regarding reduced soya bean supplies in 1976-77 was essentially about possible shortages of oilcake protein rather than soya oil, the recent rise in soya bean values has also led to higher prices for soya bean oil, and consequently for all other vegetable oils. Peak values were attained early in July, when Malaysian palm oil stood at $485 per tonne, and prices have since eased somewhat, although they may continue to fluctuate quite considerably in the short-run so long as the out-turn of the current United States soya bean harvest remains uncertain owing to possible changes in weather conditions. On 16th August oil palm prices were as follows: Nigerian palm kernels £137 per tonne; Malaysian palm oil £240 per tonne; Malaysian palm kernel oil, nominal; Malaysian palm oil $421 per tonne and Malaysian/Sumatran (resale) palm oil $422½ per tonne (see table 4). While some weakening in values was a possibility, it seemed unlikely that they would return to the low levels of early this year.

OIL PALM RESEARCH, Edited by R H V Corley, J J Hardon and B J Wood, Elsevier Scientific Publishing Company, Amsterdam and New York, Publication date September/October 1976.

As research on the oil palm, *Elaeis guineensis* Jacq., has intensified, there has been a wealth of literature published, in a number of journals, and in conference proceedings. In this book much of the work is critically discussed, and suggestions for further research are made. Previous books on the crop have had a practical bias, and little critical assessment of research progress has been made elsewhere.

The book includes 35 chapters, by 23 different authors, with sections on oil palm growth and physiology (phytosynthesis, yield and yield components), oil palm genetics, cytology and breeding, mineral nutrition, cultural practices such as planting density, pollination, pruning and irrigation, insect and vertebrate pest management (with strong ecological bias), oil palm diseases, fruit processing and palm oil end use, and a concluding assessment of the future for the crop. There are 21 plates, 129 tables and 55 text-figures, including much previously unpublished information.

Latin America

IMPROVEMENT IN THE YIELD OF YOUNG OIL PALMS IN PERU BY THE USE OF CHLORINATED FERTILIZERS.

Daniel, C. and Ochs, R., (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1975, **30**, (7), 295–298.

(In French. English, French and Spanish summaries, 18, 9 and 9 lines)

The first leaf analyses carried out on young oil palm plantations in the Huallaga Valley in Peru showed very poor chloride nutrition: 0.05 per cent Cl on dry matter for leaves of category 9.

An experiment was set up in December 1971 to compare the sulphate and chloride forms of magnesium fertilizer. The application of 1.5 kg magnesium chloride per tree raises the Cl level of the leaves from 0.038% to 0.230%; correlatively, yield increases. The plots manured with magnesium chloride have produced 129 kg bunches per tree at 4 years old or an increase of 18 per cent compared with the plots without magnesium chloride. On the other hand, magnesium sulphate does not increase yields, which remain at 108 kg bunches per tree with or without fertilizer.

The continuation of these observations should make it possible to fix the optimum level of Cl nutrition; provisionally, according to the first results, this could be 0.2% for young trees in local conditions.

THE OIL PALM UNDER IRRIGATION

Anon, *Coco y Palma, Caracas,* 1975, (8) 2.

(In Spanish)

Irrigation experiments in dry zones such as Dahomey and the Ivory Coast have shown that the oil palm responds well to irrigation. The experiments might, therefore, be applicable to the Las Majaguas project in Venezuela where there are very favourable conditions of soil, temperature, and topography, and where there are good prospects in the local market. The country has a palm oil deficiency.

USE OF A PATHOGENIC GERM IN THE CONTROL OF *Sibine fusca* (LIMACODIDAE)

Genty, Ph., (Service Entomologia, INDUPALMA, Plantation de San Alberto, A.a. 1535, Bucaramanga, Colombia) and Mariau, D., (Director of the Department of Entomology, IRHO, Bp. 13, Bingerville, Ivory Coast), *Oléagineux,* 1975, **30**, (8/9), 349–354.

(In French and Spanish. English summary, 9 lines)

The entomological fauna of the oil palm in Colombia include a number of leaf-eaters, amongst which *Sibine fusca* (Limacodidae) may occur in numbers large enough to have economic consequences.

An epizootic infection involving a virus which develops in the intestinal cells has been brought to light; it is extremely aggressive towards the larvae at all stages and death often occurs more rapidly in the youngest. The microorganism is also of very great specificity. The symptomatology of the disease is given. The first trials, which concerned the epizootic nature of the disease, led quickly to the application of industrial treatments by aeroplane, which were followed by almost 100% mortality, although with an incubation period of one month before symptoms developed. Numerous points remain to be cleared up, amongst them the maintenance of the pathogenic agent in the environment, the role of abiotic factors in these pathological processes, and the dispersion of the pathogenic agent. With regard to this last point, the large parasite complex of the pest probably plays an important role.

Far East

PRESENCE IN INDONESIA AND MALAYSIA OF A LEPIDOPTEROUS OIL PALM ROOT MINER, *Sufetula sunidesalis* WALKER AND ITS RELATIONSHIP TO ATTACKS BY *Ganoderma.*

Chenon, R. Desmier de, *Oléagineux,* 1975, **30**, (11), 449–456.

(In French and English. Spanish summary, 11 lines)

Two lepidopterous pests of the oil palm have been studied in both Indonesia and Malaysia. The most common, *Sufetula sunidesalis,* is active at night and lays its eggs at root level. The larvae (five stages) live by mining the roots. Nymphosis takes place in the soil.

Each root whose tip is destroyed produces two or three new ones which are attacked in their turn. It has been noted that zones favourable to *Ganoderma,* a fungus causing heavy damage in oil palm plantations, correspond to those which are also propitious to *Sufetula,* whose attacks may provide an entry for the fungus when climatic conditions are favourable. The respective roles of *Sufetula* and *Ganoderma* need to be defined so that a method of preventive control can be worked out.

VARIATION IN THE FATTY ACID COMPOSITION OF PALM OIL

Ng, B.H. (Malaysian Agricultural Research and Development Institute (MARDI), Layang-Layang, Johore, Malaysia), Corley, R.H.V. (MARDI) and Clegg, A.J. (Harrisons and Crosfield Oil Palm Research Station, Banting, Selangor, Malaysia), *Oléagineux,* 1976, **31**, (1), 1–8.

(In English. French and Spanish summaries, 10 and 10 lines)

The variations in the fatty acid composition between bunches, between trees, between types of fruit of *E. guineensis* and between species of *Elaeis* have been studied in several trials. Methods of sampling are defined to characterise a bunch, a tree and a group of trees. From the repeatability obtained in studies of samplings between bunches from the same palms, heritabilities have been estimated for the different fatty acids. Suggestions are made regarding the use of the varieties observed to improve the quality of the oil and the origin of the varieties is discussed.

CHARACTERISTICS OF MALAYSIAN PALM OIL

Jacobsberg, B. (Tropical Products Sales, S.A., Institut des Industries de Fermentation – Meurice Chimie, Brussels), *Oléagineux,* 1975, **30**, (6), 271–276 and (7), 319–324.

(In English. French and Spanish summaries, 11 and 10 lines)

A large-scale survey of Malaysian palm oil has been carried out. This was thought advisable because the sharp increase in palm oil production in Malaysia, which currently supplies over 65% of the world exports, made it vitally important to have accurate information on the characteristics of the oil.

The entire palm oil production in Malaysia originates from plantations, where the *tenera* hybrid is at present predominant. This ensures a fair consistency in genetic characteristics, such as fatty acid and glyceride composition. Fluctuations in analytical data of samples drawn from large batches, such as from storage and ships' tanks, may be attributed rather to oxidative deterioration than to genetic differences. It is therefore essential to minimize the causes of alteration and also to be aware of the likely degree of alteration in order to be able to forecast quality after storage and transport. A lapse of four months between production and refining is commonplace for palm oil exported from Malaysia. Previous studies on palm oil from Zaire showed a close relation between oxidation values and some fundamental characteristics of palm oil, and an attempt was therefore made to apply the same analytical techniques and interpretations of results to the Malaysian study. Seventeen tables provide considerable data on composition of the crude oil and on the correlation of crude oil characteristics with the bleachability and keeping qualities of industrially refined oil. It appears that the average quality is of high standard and that over 20% meets selected palm oil quality. The study illustrates the importance of regular and efficient quality control at all stages of production.

Africa

STUDY OF THE COMPOSITION OF *Elais guineensis* JACQ. OIL, POSSIBILITIES FOR IMPROVEMENT

Wuidart, W. and Gascon, J.P., *Oléagineux,* 1975, **30**, (10), 401–408.

(In French and English. Spanish summary, 15 lines)

The Research Institute for oils and oilseeds (IRHO) which, over a number of years, has succeeded in improving the total oil yield of *Elais guineensis* Jacq, has recently turned its attention towards improving the nutritional and technological properties of the palm oil so as to satisty both consumer and industrialist. The producer must benefit from the higher quality of his product at a time when world production is increasing and when public authorities and the press recommend, for health reasons, the use of oils rich in unsaturated fatty acids.

The study of the fatty acid composition of palm oil has led to several results. Observations of variation in the methods of extraction and conservation of the oil, in the ripeness and position of the fruit on the bunch, and in the number of bunches observed has enabled a precise method of sampling to be defined. Analysis of the origins and their crosses has shown wide variations in the percentage of unsaturated fatty acids (55% and 47% for oil originating from La Mé and Yangambi respectively, for example). It is also surprising to note the big differences between trees in their yields of fatty acids. The values observed indicate very strong heritability for each of the fatty acids, in particular stearic and oleic.

The results set forth in 10 tables and 2 figures show that the fatty acid composition of palm oil is an easily observable character for which a large amount of selection is possible because of the variability between places of origin and between trees. Moreover, the high degrees of heritability of different characteristics make possible rapid improvement by simple selection procedures. In particular it appears that an improvement in the liquid fraction could be obtained, either by directly increasing the sum of the unsaturated acids or by reducing the palamitic acid which is mainly responsible for the solid fraction. In the short term this research would make possible an immediate increase of 8 to 12 per cent in the unsaturated fatty acid content by choosing the best crosses observed and supplying planting material with a guaranteed oil composition. In this way the planter could select, within certain limits, the type of seed corresponding to the percentage of unsaturated fatty acids desired.

Hybridization between *E. melanococca* (Syn. *E. oleifera*) and *E. guineensis* offers another method of improving oil quality. This improvement depends partly on the *E. guineensis* parent; hence the double interest of the present research: to increase the unsaturated content of *E. guineensis* and use these results to obtain better quality interspecific hybrids.

It may be hoped that these two lines of research will provide new outlets for palm oil on the world fats and oils market.

General

THE MANAGEMENT OF UNDULATING AND UNEVEN TERRAIN FOR OIL PALM PLANTATIONS

Tailliez, B (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1975, **30**, (7), 299–302

It is becoming increasingly necessary nowadays to use terrain of the above kind for new plantations as level ground becomes increasingly scarce, and also to utilize areas of uneven terrain within existing plantations (so as to maximise use of the processing plant, access roads and other infrastructure already provided). The utilisation of such terrain through the construction of terraces is described. This work, and the associated building of access tracks, should be carried out between the rainy and the dry seasons so that the soil is neither very wet nor too dry. For convenient harvesting, the terraces should be about 4 metres (13 feet) wide and should be given a slope, of ca 13%, *opposite* to the general slope of the land; this is to aid water conservation and irrigation. An access track, with a similar but smaller (5%) inverse slope and 1.5 to 2.5 metres wide (depending on whether men or mules are to be used for harvesting), is built between each terrace. The palms are best planted about 0.7 m from the back of each terrace. Advice is also given on the construction of the main access roads for such a plantation.

The author mentions the incidental advantages of growing oil palm on terraces (such as facilitating access to the trees for pollination work etc. and eventual harvesting) and considers that if due care is taken with the design and construction of the terraces, the oil palm production costs should be barely any higher than for plantations on level land.

WATERING YOUNG OIL PALM PLANTS IN PLASTIC BAGS BY SPRINKLING

Quencez, P. (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1975, **30**, (8–9), 355–357 and (10), 409–411 (in French)

The requirement for water, the dose needed, and the frequency of application were defined previously (in *Oléagineux,* 1974, **29**, (8–9), 405). The present articles respectively discuss the equipment required and give an example of a typical installation. The first article states that the sprinkler method of irrigation is the best, that one hectare (2.5 acres) of the young plants needs 115 cubic metres of water per day (equivalent to 11.5 mm (0.45 inches) of rain), and that under conditions of maximum moisture demand, water must be applied for 10 hrs daily (this can include daytime watering). This is to ensure that the plants have grown sufficiently by 7–8 months to plant out. The article describes the sprinklers and the method used to pipe the water to them – indicating the type and size of pumps required.

The second article gives details of a particular oil palm nursery with its attendant sprinkler system: area occupied, 4.5 hectares containing 96,500 seedlings (enough, after allowing for 25% wastage, for a 500 hectare (1,250 acre) plantation). A plan showing the arrangement of the sprinklers, advice on their operation and similar details are included.

LAND PREPARATION OF *Imperata* SAVANNAH OR GRASS PASTURES

Martin, G. (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1975, **30**, (11), 467–470

(In French, English and Spanish)

Savannah or pasture land which is to be planted with oil palm or coconut must be subjected to very meticulous preparation so that all Graminae, some of them very hardy like *Imperata cylindrica,* are completely eliminated. This destruction is essential; otherwise the Graminae will return to compete with the young palms and the legume cover and will give rise, furthermore, to very heavy maintenance costs. Land formerly farmed but covered by re-growth is also likely to be invaded by Graminae as soon as the shrub cover is removed. In this case, too, it is always wise to provide for eradication to be done, as on savannah or pasture.

For this work experience has shown that mechanical means give very much better results than chemical treatments. This solution should be chosen, therefore, whenever the topography allows tractors to be used. In the case of *Imperata* the principle of mechanical eradication is to exhaust the reserves of the rhizomes to ensure their progressive drying up.

THE ABLATION OF THE INFLORERSCENCES OF YOUNG OIL-PALMS

Anon, (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1976, **31**, (1), 9–10.

(In French, English and Spanish)

The technique known as 'castration' (the ablation of the inflorescences) of young palms, a device used to boost the yield of good-quality fruit bunches and to encourage the tree to produce them at the most convenient time, is described in detail. This includes advice as to when the operation should be commenced and when terminated, the equipment and method used, and the precautions which should be taken against infection of the tree.

(This advice note, numbered IRHO Note 157, is a revised version of IRHO Note 62).

PALM OIL PROCESS CONTROL

Velayutham, A., *Planter, Kuala Lumpur,* 1975, **51**, 386–402

World palm oil production has doubled in the past decade, rising from 1¼ million tonnes in 1964 to over 2½ million tonnes in 1974. More than half this increase has been in Malaysia where the number of oil palm processing factories, both large and small, has risen steadily. The need for an efficient system of process and quality control has become increasingly recognised and this paper outlines one such system. The first essential is to monitor the oil and kernels that escape extraction and are lost in waste and effluents. The monitoring of these losses provides a useful yardstick for process control and is much better than calculating the oil content of the raw material (by sample analysis) and relating it to the quantity of oil produced. Because of the variations in the type, weight and ripeness of fruit bunches entering the factory, sample analysis is a poor guide. Measuring efficiency by known losses, i.e. comparing the sum of the oil produced with the oil lost during processing, gives a much more accurate result. The kernel efficiency is determined similarly by measuring the known kernel losses during processing. The article lists the main sources of loss, both of oil and kernels.

Once the oil and kernel losses are accurately measured and the percentages calculated, the process foreman must be advised. Any abnormal loss should be immediately followed up with an investigation into operator errors; change or drop-off in machine performance; change in fruit quality and condition; or improper process control techniques.

Appendices describe analytical testing procedures generally used in modern oil palm laboratories for oil and kernel losses. Other appendices describe quality control methods and provide data used for the calculation of milling efficiencies.

PALM OIL PROCESSING V. – COMPARISON OF PROCESSES AND DISCUSSION

Martinenghi, G.B. (University of Milan, via De Togni 29, 20123–Milan, Italy) *Oléagineux,* 1975, **30**, 475–477

(In French. English and Spanish summaries, 11 and 12 lines)

This paper is a short review of recent work on the technology of processing palm oil by solvent fractionation, trans-esterification, and hydrolysis/re-esterification. The author concludes that: (a) hexane appears to be the best solvent to use for the fractionation of palm oil by the solvent-fractionation procedure; (b) not only hydrogenation but also the various esterification procedures can lead to a loss, by positional and/or geometrical isomerisation, of the physiologically important linoleic acid present in the oil; (c) the most suitable method for reducing the clear point of the 'liquid fraction', obtained by solvent fractionation, from the original 15°C to ca 6°C, is by adding oils with low palmitic/stearic content.

ABOUT SOME TREATMENTS OF PALM OIL FOR EDIBLE USES

Martinenghi, G.B. (University of Milan, Italy), *La Rivista Italiana delle Sostanze Grasse,* 1975, **52**, (9), 311.

(In English. Italian Summary, 7 lines)

Among the most commonly used vegetable oils and fats, palm oil is the sole fatty material that, with a certain method of refining, possesses all the characteristics required for its many different uses without the intervention of hydrogenation. This is so whether the oil is used in liquid form for kitchen or table purposes, or as margarine. One process recommended by the author involves using two solvents, hexane and acetone, separately but in succession. The result is a first fraction of about 4%, consisting of a hard and brittle high-melting fat; a second fraction of some 41%, consisting of a homogeneous plastic fat with a middle melting point below 40°C; and a third fraction (about 49%) fluid oil containing almost 13% linoleic acid and, after neutralization, about 0.4% total carotenes. These carotenes are usually destroyed in the conventional refinery treatments.

Reference is made to experiments carried out by the author (and described in other reports and journals) designed to simplify refining methods and to encourage the wider use of palm oil.

PALM OIL STEAM REFINING, TECHNIQUES, OPERATING RESPONSES AND ECONOMICS

Rowan, C.M. and Ruths, D.W. (Parkson Corporation, Ft. Lauderdale, Fla. 33334, USA), *Oléagineux*, 1975, **30**, (10), 423–428.

(In English. French and Spanish summaries, 16 and 17 lines)

Alkali refining has for years been the standard process for the refining of vegetable oils. Palm, palm kernel, and coconut oils were also alkali-refined since their volumes were low and the installation of conventional steam refining systems was not economically justified. However, the increased supply and demand for palm oil is changing this situation. Forecasts of a rapid increase in palm oil supply in this decade has renewed interest in steam refining. The use of this technique eliminates high yield losses and acidulation. It maintains standard bleaching procedures and in general improves oil quality by comparison with centrifugal alkali refining. The crude oil must be stored in such a way as to avoid oxidation and metallic contamination and thus to ensure an optimum quality. With improved steam process conditions similar to deodorisation, it is possible to refine the crude oil by steam with overall yield improvements of 4 per cent.

Since steam refining processes can produce equivalent or superior palm oil qualities to those produced by alkali refining, the major considerations are concerned with economics and pollution abatement. A comparison of steam refining yields with those of a typical centrifugal alkali-refiner is shown in a table and proves a significant economic advantage in favour of steam. There are, however, a number of variables associated with the installation of a steam refining complex, depending on the location of the plant, the availability of auxiliaries and auxiliary equipment to run the refinery. The effects of the major variables are illustrated in two figures.

It is concluded that the economics for steam refining palm oil at volumes of 40 million lb (ca. 18,000t)/year and higher are extremely attractive. Operating costs, quality and ease of processing are also advantages compared with the centrifugal refining techniques. In addition, pollution is reduced since steam refining is a closed loop system and no acid or wash water is discharged from the plant. In general, the use of steam refining for palm oil will become more and more common, encouraged by the search for quality and the demands of the market.

PALMCO EXPANDS PALM OIL PROCESSING PLANT

Anon, *Oil Mill Gazetteer*, 1975, **80**, (6), 17

The Palmco Incorporated plant at Portland, Oregon, USA has been producing high stability, deodorised palm oil since 1973. Grosvenor Bryant, President, reports that a 50% expansion of facilities is to take place owing to increasing demand for the oil. Palmco is jointly owned by Mitsubishi International of New York and Koppel Inc. of Long Beach, California. The Sulivan Corporation, Tiburon, California will procure and design the equipment.

QUALITY ASSESSMENT OF CRUDE PALM OILS BY DIRECT BLEACHING WITH ACTIVATED BLEACHING EARTH

Hoffmann, G., Nijzink, T. and Recourt, J.H. (Unilever Research, Vlaardingen, The Netherlands), *Revue fr. Cps. gras*, 1975, **22** (10), 511–515.

(In English with French summary, 15 lines)

A simple laboratory method for the rapid routine assessment of the bleachability of crude palm oils is outlined, with the suggestion that it should be considered as an accepted international test method. It involves heating the oil, under a blanket of carbon dioxide gas, at 150°C in the presence of 5% by weight of a standard commercial bleaching earth (Tonsil Standard FF) for one hour and, after cooling and filtering, measuring the residual colour by the usual Lovibond method.

This method, known as the Direct Bleachability Test (DBT) method, is claimed to give a good indication of how easily a palm oil will be bleached if put through a typical commercial bleaching procedure without the necessity of putting the oil through the sequence of degumming, alkali-wash, etc. operations that the latter entails.

SUPPLY PROSPECTS OF PALM OIL IN THE NEXT DECADE

Khera, Harcharan Singh (Chairman, Division of Analytical Economics, Faculty of Economics and Administration, University of Malaya), *The Planter, Kuala Lumpur*, 1975, **51**, (590), 191–196.

Palm oil and palm kernel are the joint products of the oil palm industry. The emphasis in both Malaysia and Indonesia has been on the production and export of high quality palm oil, as the Deli *dura* and *tenera* palms grown in those countries yield fruit with a high proportion of the pericarp rich in oil. By contrast, the greater part of the oil palm industry in West Africa is still dependent on the exploitation of many semi-wild palms which produce fruit with less palm oil than plantation fruit. Moreover, most of the palm oil produced in West Africa is consumed

ry the substantial domestic market, whereas almost all the palm oil produced in Malaysia and Indonesia is exported.

After remaining fairly stable for about 10 years (1957–67), world production of palm oil showed a sudden upturn in 1968. This rapid rise was due largely to a continuation of spectacular growth in the Malaysian industry which had occurred in the previous decade but which had been largely offset by production losses in Nigeria, Indonesia and Zaire resulting from political disturbances. A number of other countries also contributed to the overall production and this trend continues. In the Ivory Coast, for example, production of some 280,000 tonnes of palm oil is likely by 1980. Oil palm cultivation is also being developed in several Central and South American States. In addition to those in Mexico, plantations have been established in Honduras, Costa Rica, Ecuador, Dahomey, Cameroon and Colombia. World production is therefore increasing considerably and at a faster pace than in the 1960s or 1950s. Palm oil is expected to account for nearly 8% of total world supplies of oils and fats by 1980, as against just over 4% in 1970. This increased production means that palm oil exporters face a considerable task in finding markets for the greatly increased quantities likely to become available. However, because the supply increases are relatively assured and production costs are low, palm oil is likely to offer stiff competition to other oils and fats on the international markets. In addition, palm oil's chemical properties make it suitable for a wide variety of uses, and much research into quality control, processing and end-uses is being carried out.

PALM OIL MARKET ATTRACTS MORE ENQUIRY

Anon, *Public Ledger,* April 14, 1976, page 3.

C. Itoh and Co are reported to be negotiating the supply to Iraq of about 220,000 tonnes of palm oil over two years. In recent years, the Japanese company – the Sales agent for Indonesia palm oil – has been selling 30,000 to 40,000 tonnes of palm oil annually to Iraq, the latter consuming a yearly total of about 100,000 tonnes.

PALM OIL THREAT GROWS

Graham, L., *Soybean Digest,* March 1976, page 8.

This article points out that not only is the production of palm oil by Third World countries (in particular, Malaysia) rapidly increasing but that imports of palm oil and palm kernel oil into the USA itself are steadily rising; to the extent that these imports are now threatening to undermine the home soya bean oil market. This is partly because palm oil products are considerably cheaper to produce than the soya bean oil equivalents, the annual yield of oil per acre greatly exceeding that obtained from the soya bean plant and the trees remaining in full production for many years. The article mentions that a part of this expansion in palm oil production has been financed by USA foreign aid and discusses possible future action by the United States Dept of Agriculture to restrict, by voluntary means if possible, the import of palm oil into the country.

PALM OIL GAINING

Anon, *Oil Mill Gazetteer,* 1975, **80**, (4), 18–19

The article points out that the US Dept. of Agriculture had predicted that world production of palm oil would exceed 2.8 million metric tons in 1975, a 10% increase on 1974, thus maintaining the steady upward trend of recent years. Most of this increase is from Malaysia with a little from Indonesia and from the Ivory Coast and by 1980 production will reach 4.3 million tons, representing ca 20% of the world vegetable oil market. Similarly, palm kernel oil production, although less (ca 0.5 m tons expected in 1975), is also climbing steadily.

These upward trends in palm oil and palm kernel oil production are making soya bean oil manufacturers in the United States rather apprehensive: they feel palm oil could soon begin to represent a major threat to the soya bean oil market, particularly now that the price of palm oil has sunk below that of soya bean oil. To combat this threat, various US authorities are considering asking for a programme of voluntary restraints by the exporting countries in the future, a review of US financial aid directed towards the development of Third World palm/coconut oil export capabilities, and a review of the current practice of exacting no import duty on palm oil while 2.5 cents/lb (0.454 kg) is levied on other vegetable oils.

ANALYSIS OF MESOCARP AND KERNEL OILS FROM THE AMERICAN OIL PALM AND FROM F_1 HYBRIDS WITH THE WEST AFRICAN OIL PALM

Macfarlane, N., Swetman, A. and Cornelius, J.A. (Tropical Products Institute), *J. Sci. Fd Agric.*, 1975, **26**, 1293–1298

The component fatty acid composition and iodine value of the mesocarp and kernel oils of the American oil palm *(Elaeis oleifera)* and of the F_1 hybrids of this species with various West African palms *(E. guineensis* with variously *dura, tenera* and *pisifera* fruit types) grown both in Nigeria and in Colombia are reported and compared with data obtained on a typical *E. guineensis* palm.

The kernel oils of the various Nigerian and Colombian hybrids resembled one another in both fatty acid composition and iodine value, and approximated the values typical of an *E. guineensis* palm. The hybrid oils should therefore be acceptable to the established kernel oil trade while the hybrid palms have the advantages, as compared with the *E. guineensis* palm, of higher resistance to bud rot and spear rot in Colombia, and the shorter stature facilitates harvesting. The kernel oil of the American

parent is higher in myristic, oleic and linoleic acids and lower in lauric, than its African counterpart, and overall is more unsaturated.

The mesocarp oils of the hybrids, regardless of the fruit type, were intermediate in overall unsaturation and fatty acid composition to those of the parents; that is more unsaturated and lower melting than *E. guineensis* oil and so having transportation and stability advantages.

Training

The Bureau is prepared to advise management in the oil palm industry on the training of personnel. Details of the nationality, linguistic abilities and educational background of the candidate would be needed, together with the purpose for which training is required.

Information

The Tropical Products Institute has one of the world's best libraries of periodicals and works of reference dealing with the products of developing countries and photo-copies of articles dealing with the oil palm can be provided on request. Answers to technical queries concerning the oil palm can also be dealt with; certain agronomic or engineering inquiries might have to be referred outside the Institute, but the Secretary of the Bureau would endeavour to find the best source of information.

In general, no charge will be made for any of the services provided but, if in a specific instance any charge has to be made, the inquirer will be notified in advance before he is committed to any costs.

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OIL PALM NEWS

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This issue includes an up-dated version of the paper concerning the propagation of the oil palm by tissue culture presented at the International Agricultural Oil Palm Conference in Kuala Lumpur in 1976 and referred to in our previous editorial. The success to date could well be a highly significant factor in the future speed and direction of breeding research and development.

An article describing a cheap method for large-scale simultaneous oil palm mesocarp analysis of large numbers of samples will also be of interest to breeders and another on palm oil fractionation will be of considerable interest to oil palm processers.

The regular market review item from the Commonwealth Secretariat has been a popular feature almost since this journal's inception. It is therefore with regret that the Editor has to announce that, owing to organisational changes within the Secretariat, they can no longer contribute this item. However, the Marketing and Industrial Economics Department of the Tropical Products Institute has stepped into the breach at fairly short notice to produce the review for this issue using the most recent sources of information available to them.

The Editor would be glad to receive articles and comments for the 23rd and future issues of *Oil Palm News* as soon as possible.

(07878)

Vegetative Propagation of Oil Palm via Tissue Culture*

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Summary

Vegetative propagation of oil palms has been achieved using tissue culture methods, and several hundred plants are now established in a polybag nursery in Malaysia. Characteristics of these 'clonal' plants are described, and compared with those of seedling material. Finally, the possible value of vegetative propagation to the oil palm industry is discussed.

Introduction

In general plants can be propagated, either by vegetative methods or by conventional seed production. In most outbreeding crops, seedling progenies are variable. Although great improvements to the oil palm have been made by conventional methods of breeding, there is still variation in the progenies of the best hybrid oil palm crosses. Greatly enhanced yields could be attained if the best individual palms could be vegetatively propagated.

Vegetative propagation (traditionally by, for example, taking cuttings or grafting) has the advantage of allowing one to obtain uniform plant material with whatever attributes the grower requires, be it high yield or particular oil quality. All that is required is to identify an individual tree carrying the desired combination of characters. The amalgamation of conventional cross pollination breeding to produce the best genetic combinations, and a rapid vegetative method to multiply the best selections should allow further rapid progress towards the breeder's main objective of higher oil yields. At the same time it would permit greater attention to be given to secondary objectives.

Hitherto there has been no method for vegetative propagation of oil palm. Recently, however, tissue culture methods have been developed which promise to provide the necessary techniques for large scale rapid multiplication of selected individual palms. Details of this technique and the possible benefits it might bring were described earlier (Jones, 1974; Rabechault and Martin, 1976). Briefly, the technique of tissue culture involves taking small pieces of plant tissue from any selected tree and growing it in a nutritive medium. The cells in the tissues grow and divide in a disorganised way to form a callus. The callus can be divided and subcultured many times. The cells of the callus are all 'daughters' of

*The material presented here is an updated version of a paper presented to the Malaysian International Agricultural Oil Palm Conference, 1976.

Figure 1 Young palms of clone JB32 in a polybag nursery at Kluang, Malaysia, January 1977.

the original piece of tissue, and carry the same genetic information in their nuclei. When growth conditions are changed, new plants form in the cultures, all genetically similar to the original palm from which the tissue piece came. They are all members of one clone.

Since the previous report in *Oil Palm News* (Jones, 1974), several hundred oil palm plantlets have been successfully transplanted from the culture medium into soil, and the first clonal oil palms are now established in a polybag nursery in Malaysia (Figure 1).

In this paper we shall describe these plantlets and discuss some of the possible uses of tissue culture propagation methods with the oil palm.

Methods

Plantlets were produced using the methods described by Jones (1974). The clones discussed in this paper were obtained from commercial D x P seedlings, germinated aseptically in Britain. Plants of ten different clones have so far been produced. After establishment in a soil-free compost in growth cabinets in Britain (cabinet conditions given in Table 2), the plantlets were transferred by air to Malaysia (bare root plantlets in order to meet quarantine requirements) and planted in a conventional polybag pre-nursery. Leaf areas were estimated non-destructively from length and width of the leaf (see Corley, 1976). Dry weights were measured on a sample of plants, and growth rates calculated using standard formulae (see, for example, Radford, 1967).

Chromosome counts were made on root-tip squashes, using the feulgen or aceto-carmine methods (Darlington and LaCour, 1966).

Results

A. Establishment of plants in the nursery

In all, five shipments of plants have now been air freighted from Britain. With the first shipment, no special precautions were taken to minimise transplanting shock, and Table 1 shows that the percentage establishment was very low.

With the second shipment, a number of treatments intended to reduce transplanting shock were applied; these included varying degrees of leaf pruning, and use of an antitranspirant. In addition, with the co-operation of the Plant Protection Division of the Malaysian Department of Agriculture, the interval between uprooting in the UK and replanting in Malaysia was considerably reduced. Table 1 shows that survival was much better, but there were still losses from the less favourable treatments.

For shipments 3 and 4 the best treatment found in shipment 2 was applied to all plants. This involved removal of about half the total leaf area, together with an antitranspirant dip. As the table shows, survival from both shipments was over 90 percent.

Table 1 Nursery establishment of plants received from Colworth House

Shipment	Number of plants	Percentage surviving
1	27	19
2	100	84
3	53	92
4	100	91
5	69	96

B. Growth of clonal plants

The first cultured genotype to produce plantlets in sufficient numbers for experimental comparisons to be made was designated JB 32 (Experiment 32 of J N Barrett). At the present time we have most data available for plants of this clone, but more recently derived clones are now becoming available in greater numbers.

Initially it was necessary to demonstrate that plants derived from tissue culture had normal rates of growth and development, and the first plants of clone JB 32 were compared with normal seedlings. The growth analysis data for plants of JB 32 shown in Table 2 were made on plants growing in a growth cabinet in Britain, but in general plants growing in polybags in Malaysia gave similar results. The figures are derived from three polybag pre-nursery trials in Malaysia (Corley, unpublished data).

Table 2 Mean growth rates of plants of clone JB 32 in a growth cabinet* compared with typical seedling data

	JB 32	Seedlings
Relative leaf area growth rate (%/d)	3-4	3-5
Relative growth rate (%/d)	4	3-4
Net assimilation rate g/m^2/day	4.4	4-5
Leaf area ratio dm^2/g	0.8	0.6-0.8
Specific leaf area dm^2/g	1.9	1.4-1.9
Root/shoot ratio	0.16	0.3-0.6
Leaf production (leaves/month)	1.95	1.5-2.0

*Growth cabinet conditions: 30°C; 80% relative humidity; irradiance 10 mW/cm^2 (visible 6 mW/cm^2); day length 18 hours.

Destructive growth analysis measurements are not possible when only a few plants are available, but as more new clones have been regenerated from culture it has been possible to make preliminary non-destructive measurements of relative leaf area growth rate (Ra) on plants in the nursery.

Ra was measured for two clones, and for typical seedlings, over a 6 month period. Table 3 shows that the rates are comparable.

Table 3 Relative leaf area growth rates for two clones, and for seedlings, between July and December 1976

Material	Ra (percent/day)
Clone JB 32	1.75
Clone JB 20. 32	1.80
Seedlings	1.93

Relative leaf area growth rates have also been measured over an 18 day period for 7 clones from shipment 4. Table 4 gives mean growth rate for different clones; analysis of variance showed highly significant differences between clones.

Table 4 Relative leaf area growth rates for seven clones in the pre-nursery (December 1976)

Clone	Number of plants	Ra (percent/day)
JB 32	30	1.51
JB 12	31	1.76
171.97	10	2.14
JB 20. 60 A	9	2.16
JB 22. 24 C	4	1.81
JB 20. 49 A	4	2.04
JB 30	4	1.95
Standard error		0.10

Corley, Barrett and Jones (1976) found that plants of clone JB 32 had a root/shoot ratio appreciably below the normal range for nursery seedlings. They suggested that this might be due to low light intensity in the growth cabinet in which the clonal plants had been grown. Destructive analysis of a small number of plants of clone JB 32 at various times after establishment in the nursery in Malaysia showed that the root/shoot ratio increased in proportion to the number of days for which the plant had been actively growing ($r = 0.75$, $p < 0.05$, $df = 8$). From an initial figure of 0.1 at time of arrival, the ratio increased to over 0.3 (a reasonable figure in comparison with seedlings) 110 days after measurable leaf growth commenced. Thus, once growing under normal nursery conditions (with high light intensity) the plantlets appear to establish a normal root/shoot ratio.

C. Variability of clonal plants and of seedlings

Relative leaf area growth rates have been measured on 60 plants of clone JB 32, in a polybag nursery, over a 6 month period and the variation between these plants compared with the variation seen in batches of seedlings. The seedling seedlings were commercial D x P crosses and included two groups of siblings from single progenies. Seedlings with the same parentage represent the nearest to genetic uniformity which can be achieved with conventional seed production, unless selfing or inbreeding are resorted to. The third seedling group consisted of mixed progenies; each plant was paired with a clonal plant, on the basis of leaf area and morphology, soon after the clonal plants were established in the nursery. Table 5 shows that the coefficient of variation (CV) is lower for the clonal palms than for any of the groups of seedlings. This is encouraging, in view of the fact that Tan and Hardon (1976) concluded that most of the variation between nursery seedlings was not of genetic origin. (Mixed seedlings would normally have a higher (CV) than single progenies, but abnormal plants were automatically excluded from the former, during the process of pairing with the clonal plants).

Table 5 Coefficients of variation in Ra for clone JB 32 and for seedlings

Material	CV (%) (for 60 plants)	After 'rogueing' CV (%)	Number of plants
Clone JB 32	7.1	–	–
Mixed seedlings	8.9	7.9	57
Progeny 'C'	10.6	6.1	56
Progeny 'D'	8.7	7.4	54

When the seedlings are 'rogued' (by excluding abnormally slow growing plants, constituting 5 to 10 percent of the total), CV can be reduced to a level comparable with that for the clonal plants. However, some of the variability removed by rogueing is probably environmentally induced, since a few slow growing plants can also be identified within clone JB 32.

D. Chromosome number

One problem with propagation via tissue culture in other species is that changes in chromosome number sometimes occur (e.g. Teo and Teo, 1974) thus causing genetic diversity in the resulting material. Smith and Thomas (1973) found a high proportion of abnormal cell divisions, and polyploid (with multiple chromosome sets) and aneuploid cells, (with odd chromosomes missing) in a strain of unusually fast-growing oil palm callus. However, it has not been possible to regenerate plantlets from this particular callus strain.

We have looked at mitosis in root tips of the clonal plants, and all those examined so far appear to be normal diploid plants (Figure 2). In this context, however, it is worth noting that Tan (1976) found that about 6% of mitoses in root tips of apparently normal D x P seedlings were abnormal in some way. Thus a small proportion of abnormal mitoses is also likely to occur in the clonal plants.

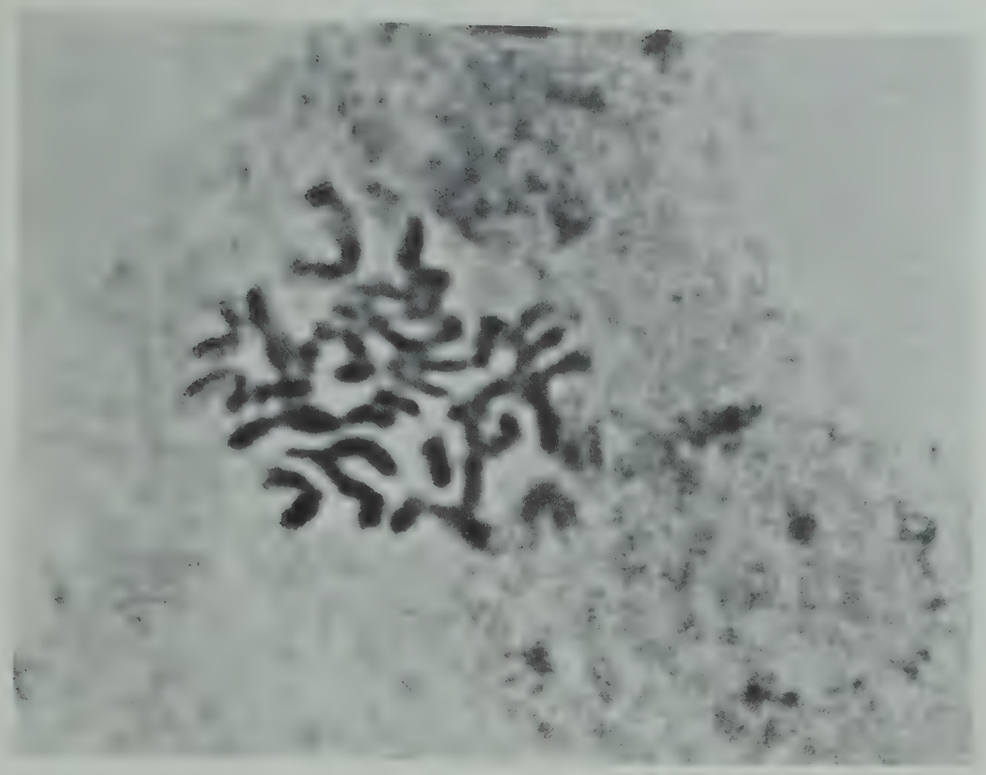

Figure 2 Chromosomes in metaphase in the root tip of young palms from clone JB 32

Discussion

Results obtained with the first oil palm clones are encouraging. The very extensive transplanting shock with the first shipment was apparently not a result of any unusual susceptibility of the clonal plants, since some seedlings included in the shipment also suffered. The better results with the second shipment indicate that the long transit time, probably accompanied by water stress, was the cause of the losses from the first shipment. In future, transplanting should be less of a problem, since most clones will be produced in Malaysia rather than in Britain.

So far as performance of the clonal plantlets is concerned, preliminary results are satisfactory, but further growth measurements in the nursery and later in the field will be required before we can confirm that the material behaves normally in all respects.

The first three vegetatively propagated palms were field planted in January 1977, and have recently (June 1977) been followed by a further batch of 60 palms (clone JB 32) from which the first measurements will be made of clonal variability under field conditions.

We must emphasise that these first clones were obtained from unselected seedlings (seedlings were used because it was difficult to obtain fresh explants from mature palms in Britain); thus we have no information concerning the yielding ability of these clones. The important point with this material is that it should show greater uniformity than normal seedling populations, but there is no reason to anticipate any great improvement in yield. Work is now in progress using explants from selected mature palms, from which yield improvement can be expected; indications are that production of plantlets will present no difficulties.

On the scale reached at present, this technique for vegetative propagation will be a valuable tool for the oil palm breeder. The ability to propagate the best parent palms, even in small numbers, would allow a considerable increase in the number of seeds of specific crosses which could be produced. Thus selection of parent palms could be much more rigorous. Culturing from embryos or seedlings would allow more accurate estimates of environmental variation in genetic experiments. Precision in agronomy trials could also be increased if it were possible to plant even small areas with genetically uniform material.

There are various other ways in which tissue culture may be of advantage to the oil palm breeder. In other crops it has been possible to culture and regenerate from pollen grains, thus giving haploid plants (that is, plants with only a single set of chromosomes). Doubling of the chromosome number then gives homozygous diploid plants (carrying the normal double set of chromosomes), thus affording a means of producing genetically uniform F_1 hybrid varieties. Starting with haploid cells, mutations might be deliberately induced, thus further increasing the genetic range at the breeder's disposal. Screening of such mutants could be carried out in culture, and plantlets would be regenerated from cell colonies shown to possess the desired attribute. Characteristics which might be selected for in this way include disease resistance, drought tolerance and herbicide tolerance.

The major impact of the technique on the oil palm industry will come once it is possible to obtain clonal plantlets from

selected mature palms in sufficient quantities for commercial planting. It is worthwhile to consider the possible benefits. The highest yielding palms in a present day D x P progeny trial will generally produce as much as 50% more than the overall mean. However, such palms are often strong competitors, tending to overshadow their neighbours, so might not yield so well in a uniform stand of similar palms (Corley *et al.*, 1971). Further, yield has a low heritability; that is, most of the variation between palms is environmental, not genetic, and hence would still occur in clonal planting. Thus direct selection for high yield per palm may not be very successful.

A more promising approach would appear to be to select palms with various physiological characters known to be under a reasonable level of genetic control (Hardon *et al.*, 1972). The main objective would be to increase bunch index (the proportion of dry matter used for bunch production) and leaf area ratio (the ratio of leaf area to dry weight), while at the same time decreasing the amount of dry matter incorporated into vegetative tissues. Such palms would be expected to perform well at high planting density, thus giving high yield per hectare even though yield per palm might not be outstanding (Hardon *et al.*, 1972). We estimate that fruit yields as high as 40 tons per hectare could be achieved with such material.

Fruit quality characteristics also have reasonably high heritabilities, and individual palms already exist with oil to bunch ratios of over 30%. If clones combining high oil to bunch ratio with high bunch yield per hectare can be produced, then yields as high as 12 tons of oil per hectare per year should be possible.

In addition to the primary objective of increasing oil yields, vegetative propagation will allow greater attention to be given to secondary objectives. Some such objectives are already included in conventional breeding programmes. These include short trunks, disease resistance, and more desirable oil composition. Further possibilities could include drought tolerance, herbicide tolerance, greater efficiency of fertilizer use, reduced requirement for assisted pollination (low sex ratio, or high tendency to set parthenocarpic fruit), or suitability for mechanical harvesting (long bunch stalks, low rate of ffa build-up). Many of these characteristics are found within the hybrids and backcrosses between *Elaeis guineensis* and *E. oleifera*. Only a single palm combining the desired characteristics need be identified, and clonal planting material can then be produced from it. However, the dangers of possible susceptibility to pest or disease attack when large areas are planted with single clones must not be forgotten; an adequate range of clones must be available before commercial planting begins.

It should not be thought that conventional breeding programmes will cease to be necessary. The breeder will continue to create variable populations, from which elite palms will be selected for propagation, and further development of selection and screening methods willprobably be necessary.

Conclusion

On the scale reached so far, vegetative propagation will be a valuable tool for the research worker. However, we think it probable that the technique can be further developed to allow large-scale production of clonal material for commercial planting. We believe that the introduction of clonal planting material will represent an even greater advance for the oil palm industry than did the replacement of *dura* by *tenera* planting material in the 1950's.

Acknowledgements

We are grateful to A H Green and W K Smith for discussions and comments.

References

Corley, R H V (1976) Germination and seedling growth. In: *Oil Palm research* (eds. R H V Corley, J J Hardon and B J Wood), pp. 23-36 Amsterdam: Elsevier Scientific Publishers.

Corley, R H V, Barrett, J N and Jones, L H (1976) Vegetative propagation of oil palm via tissue culture. *Pa, pres. Malaysian Agricultural Oil Palm Conference, Kuala Lumpur 1976.*

Corley, R H V, Hardon, J J and Tan, G Y (1971) Analysis of growth in oil palm. 1. Estimation of growth parameters and application in breeding. *Euphytica,* **20**, 307-315.

Darlington, C D and LaCour L F (1966) *The handling of Chromosomes.* London: George Allen and Unwin, 263 pp.

Hardon, J J, Corley, R H V and Ooi, S C (1972) Analysis of growth in oil palm 2. Estimation of genetic variances of growth parameters and yield of fruit bunches. *Eyphytica,* **21**, 257-264

Jones, L H (1974) Propagation of clonal oil palm by tissue culture. *Oil Palm News,* **17**, 1-8.

Rabechault, H and Martin, J P (1976) Multiplication végétative du palmier à huile (*Elaeis guineenis* Jacq.) à l'aide de cultures de tissus foliares. *C.R. Acad. Sci., Paris,* t283:Série D, 1735-1737.

Radford, P J (1967) Growth analysis formulae – their use and abuse. *Crop Sci.*, **7**, 171-175.

Rees, A R (1963) An analysis of growth of oil palm seedlings in full daylight and in shade. *Ann. Bot.*, **27**, 325-337.

Smith, W K and Thomas J A (1973) The isolation and *in vitro* cultivation of cells of *Elaeis guineensis. Oléagineux* **28**, 123-127.

Tan, G Y (1976) Cytology and cytogenics. In: *Oil Palm research* (eds. R H V Corley, J J Hardon and B J Wood), pp. 145-153. Amsterdam: Elsevier Scientific Publishers.

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Tan, G Y and Hardon, J J. (1976) Nursery Selection, In: *Oil palm research* (eds. R H V Corley, J J Hardon and B J Wood), pp. 139-143. Amsterdam: Elsevier Scientific Publishers.

Teo, C K H and Teo F S. (1974) Are orchid mericlones true to type? *Planter, Kuala Lumpur,* **50**, 234-236.

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A Cheap, Cold, Counter-current Oil Extraction Method for Large-scale Oil Palm Mesocarp Analysis using Regular Grade Petrol

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Summary

A cheap method of cold oil extraction is described that produces similar results to conventional Soxhlet extraction using ordinary grade petrol as a solvent. By using a counter-current system of 8 extractions only 100 ml petrol is needed per complete extraction of 50g dried and pounded mesocarp. The investment cost in extraction apparatus is virtually nil. The system can deal with almost any number of samples.

Introduction

Two main aspects can be distinguished in the breeding for high yielding varieties of the oil palm (*Elaeis guineensis* Jacq.) i.e. the bunch yield and the quality of the bunch. The two important parameters in respect of bunch quality are the percentages oil to bunch and kernel to bunch. The calculation of the oil to bunch ratio requires an oil determination on the mesocarp of the fruit.

Blaak (1970 and 1971) described a cheap counter-current oil extraction technique suitable for large scale bunch analysis using cold petroleum spirit (60-80°C). His technique allows a quantitative analysis of all mesocarp of a 100g fruit sample. The technique is cheap, easy and flexible, requires a very small initial investment as compared with other methods of oil analysis and is as reliable as conventional soxhlet extraction. The method was used in ten thousands of oil analyses without complications. There still remain some problems, not related to the method of analysis, such as the difficulty of obtaining petroleum spirit in some tropical countries, high import duties and the need to recover the petroleum spirit from the palm oil-solvent mixture.

An improvement on the economy of the cold counter-current oil extraction is described in this article. Ordinary grade petrol obtainable from any petrol station is used for extraction. The advantages are the cheapness of the solvent, its availability and the elimination of the solvent recovery, which is tedious and somewhat dangerous.

Methods and Materials

Oil extraction was carried out with Whatman paper extraction thimbles. The thimbles plus cotton wool plugs were dried (before filling) for 12 hours at 105°C and weighed when warm. A bulk sample of dried, pounded mesocarp of *tenera* fruit was prepared. About 40 to 50g of this mesocarp was placed in the thimbles. The thimbles with their content were dried at 105°C for 12 hours and weighed immediately after removal from the oven. After the oil extraction the thimbles were allowed to stand in a well aerated place for several hours and dried at 105°C for 12 hours subsequently. The loss in weight was taken as oil extracted.

Ordinary discarded, plastic knapsack sprayers were used as containers for the cold solvent extraction. A small metal screen was installed at about 2 cm from the bottom to allow solvent drainage of the samples. The tube leading to the spray beam was used for drainage. In one series of experiments a comparison was made between repeated extraction with ordinary grade petrol, petroleum spirit (60-80°C) and soxhlet extraction for 8 hrs with petroleum spirit (60-80°C). The results are indicated in Table 1.

In the second series of experiments the counter-current extraction as described by Blaak was carried out using regular grade petrol and directly compared with a soxhlet extraction using petroleum spirit (60-80°C). The system of extraction is indicated in Diagram 1.

Diagram 1 System of solvent transferes in the cold counter-current oil extraction of water-free and pounded oil palm mesocarp samples.

Day	Hour	Number of changes in most extracted sample	Containers A B C D E F G H etc.
1	8		
1	16	1	A→discard used solvent
2	8	2	A→B
2	16	3	A→B→discard used solvent
3	8	4	A→B→C
3	16	5	A→B→C→discard used solvent
4	8	6	A→B→C→D
4	16	7	A→B→C→D→discard used solvent
5	8	8	A→B→C→D→E
5	16	7	↓ B→C→D→E→discard used solvent
6	8	8	*dried B→C→D→E→F
6	16	7	↓ C→D→E→F→discard used solvent
7	8	8	dried C→D→E→F→G
7	16	7	↓ D→E→F→G→discard used solvent
8	8	8	dried D→E→F→G→H
			etc.

* Samples are air- or sundried during the day, oven dried at 105°C during the night and weighed next morning.

It is important to allow drainage of the solvent from the thimbles for a few minutes before transfering the solvent. The solvent quantity is just sufficient to submerge the thimbles.

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Ordinary filter paper was used to fold thimbles. The seams were double-folded and stapled to prevent particle wash. The performance of these thimbles, which are about 15 times cheaper, was compared with ordinary Whatman paper extraction thimbles. Home-made thimbles may be preferable when labour is cheap and/or import duties on Whatman thimbles are high.

Results

The results of a comparative test on oil extraction with ordinary grade petrol and petroleum spirit (60-80°C) are indicated in Table 1. Different samples were employed for each observed value.

Table 1 Percentage oil extracted from water-free, pounded oil palm mesocarp with ordinary grade petrol and petroleum spirit (60-80°C). The cold solvent was changed every 12 hours.

Extraction number	Petrol	Petroleum spirit 60-80°C	Difference (p - ps)
1	59.5	58.4	1.1
2	73.2	71.9	1.3
3	75.5	74.9	0.6
4	76.7	77.5	-0.8
5	77.7	78.5	-0.8
6	77.7	79.0	-1.3
7	78.9	78.7	0.2
8	80.3	79.4	0.9

Control samples were Soxhlet extracted with petroleum spirit (60-80°C) for 8 hours. The oil to dried mesocarp ratio was 78.5% ($\sigma x = 0.4$, $n = 3$).

A different bulk sample was used for the counter-current extraction. Four extractions according to Diagram 1 indicated 75.8% oil to dried mesocarp, 8 extractions 77.7% ($\sigma x = 0.46$, $n = 4$) and soxhlet extraction 76.2% ($\sigma x = 0.3$, $n = 3$).

A bulk sample was prepared from the mesocarp of an *Elaeis oleifera* (syn *melanococca) dura* to compare the extraction of Whatman paper thimbles against thimbles folded from filter paper. The extraction with Whatman thimbles was 39.4% ($\sigma x = 1.7$, $n = 5$) and with folded thimbles 40.0% ($\sigma x = 1.0$, $n = 5$) oil on dried mesocarp. Folded thimbles give a slightly higher value that is insignificant but there might have been some particle wash.

Discussion

The extraction rate of water-free, pounded mesocarp is very similar with petrol and petroleum spirit (60-80°C) (See Table 1). The soxhlet extraction gives results very similar to 6-8 cold extractions. There seems no objection to replacing petroleum spirit (60-80°C) with ordinary grade petrol in the cold extraction method. This observation is confirmed in the second experiment using the cold counter-current extraction. In 4 extractions 99.5% of the oil is removed as compared with the soxhlet extraction, and 8 extractions seem an ample safety margin to ensure a good extraction.

It is important to pound the dried mesocarp until it becomes oily. Another source of errors concerns the drying and weighing of samples. Empty thimbles, thimbles with dried mesocarp and thimbles with extracted mesocarp should preferably be dried overnight at 105°C and weighed immediately after removal from the oven in view of the high relative humidity in the tropics.

The folded filter paper thimbles gave 0.6% higher extraction of oil on dried mesocarp. This represents only a difference of 0.3% in oil to fresh mesocarp and is negligible. Folded thimbles can be used when circumstances require this. They have the advantage that they can be used as disposable thimbles and this saves time in cleaning.

It requires 800ml solvent per sample when 8 extractions are each made with fresh solvent. However, with the counter-current extraction only 100ml per sample is needed once the system is in continuous operation. As from day 5 one batch of samples is removed and one batch is added per day, as can be observed in Diagram 1, and one charge of solvent removed from the system.

The transfer of the solvent from one container to the next is simply done by gravity.

Discarding the oil-petrol mixture, because of the low price of the solvent, saves the staff time in solvent recovery, electricity, the investment in the recovery apparatus and eliminates a fire hazard in the laboratory.

References

Blaak, G. (1970) L'extraction de l'huile, à froid, dans l'analyses des régimes de palmier a huile, *Oléagineux*, 25, (3), 165-168.

Blaak, G. (1971) Cold oil extraction in oil palm bunch analysis. *Oil Palm News*, 10/11, 25-29.

Some Theoretical and Practical Aspects of Fractionation of Palm Oil*

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Introduction

A number of recent general discussions on the fractionation of oils and fats are available (Coenen, 1974; Rek, 1973; Thomas and Paulica, 1976) and therefore in the present review it is proposed to deal only briefly with general principles but to concentrate on reviewing information that is particularly pertinent to the fractionation of palm oil.

Definition

Fractionation involves a partial crystallization followed by the separation of the solid from the liquid portions.

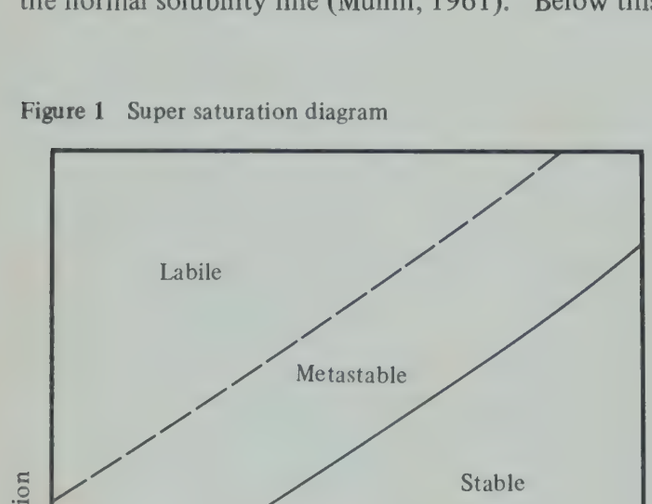
Crystallization

The process of crystallization involves three distinct stages.

1. *Super-saturation*

The solution must be supersaturated or supercooled, that is, it must contain more solute than would dissolve under equilibrium conditions. If we draw a simple diagram (Figure 1) of concentration against temperature we have the the normal solubility line (Mullin, 1961). Below this is a stable zone where crystallization is impossible. Above it there is a metastable supersaturated zone where spontaneous crystallization is unlikely but crystallization can be induced by seeding. Then we can draw another line less clearly defined, above which lies an unstable or labile zone where spontaneous crystallization is probable.

Figure 1 Super saturation diagram



To get from the stable to the labile zone, it is necessary either to reduce the temperature or to increase the concentration. Only the former method is applicable to fats.

2. *Nucleation*

The next necessary step is the formation of nuclei. Spontaneous or homogeneous nucleation is that in which no outside agency is involved. The mechanism is still obsecure, but what needs to happen is that 100 or perhaps 1000 molecules must come together and arrange themselves in a lattice. Clearly this is not possible as a result of collisions alone. As the lattice is formed the molecules have restricted movement and there is a release of energy. A degree of supercooling is required, but an excessive amount inhibits the formation of nuclei due to the increase in viscosity. Very rapid supercooling leads to the formation of glasses.

Agitation helps induce nucleation, reducing the extent of supercooling required.

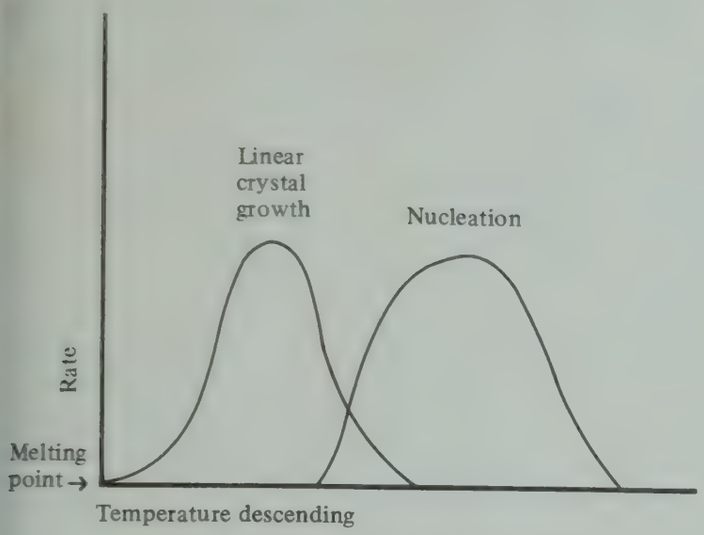
The optimum temperature for nucleation is usually much below that required for maximum crystal growth.

The effect of temperature on rate of formation of nuclei and on crystal growth is shown in Figure 2.

A moderate degree of supercooling leads to the formation of few nuclei, excessive supercooling increases viscosity and decreases molecular mobility so that eventually nucleation ceases. The degree of overlap for pure substances between the nucleation and crystal growth curve varies. Thus for a pure substance it may be necessary to raise the temperature after obtaining nucleus formation if a high rate of crystal growth is desired. This is not the case with palm oil, because it is a mixture of glycerides. In a typical commercial process supercooling to between 40-45^{o}C is sufficient to cause nuclei of the trisaturated glycerides to form, (Tripalmitin melting point 66^{o}C) althou it would not be sufficient to induce nucleation in the unsaturated glycerides.

*Presented at the American Oil Chemists' Society Meeting, Chicago, October 1976

Figure 2 Nucleation and crystal growth



In order to obtain predictable nucleation effects, it is important to heat palm oil to 70°C so that any residual nuclei already present are destroyed. The oil is then cooled according to a predetermined programme. It is interesting to note in passing that when texturising margarines and shortenings a different effect is aimed at. A great many small crystals give the desired texture, and therefore rapid and severe supercooling in an efficient scraped surface heat exchanger is used.

Heterogeneous nucleation takes place when foreign matter acts as a nucleus on which the solute molecules can start to build a lattice. The presence of such foreign matter, which may be dust or impurities, enables nucleation to take place at a lesser degree of supercooling.

3. *Crystal growth*

Crystal growth follows as soon as stable nuclei are present. Other conditions being constant, crystal growth is aided by agitation, which should not be too vigorous. The growth rate is determined by a number of factors including molecular geometry, temperature and viscosity. Too low temperatures result in high viscosity and reduced crystal growth rates as indicated in Figure 2.

All the fractionation processes that use a filtration step require relatively large crystal aggregates of good mechanical strength. The shape of the aggregates is also important. Spheres of fairly uniform size distribution leave a high proportion of void spaces aiding removal of the liquid phase. Spheres of a heterogeneous size distribution have less voids, whereas crystals of platelet or needle shape are capable of very tight packing and hence impede filtration. These factors are taken into account in devising the cooling and crystallization programme so that relatively few nuclei are formed, and there is sufficient time for crystal growth. For example Weisser *et al.* (1975) aimed at spherulites of 100-200 μm cross section, by tempering at 50°C for several hours to obtain nucleation. He found that the addition of only 0.1 ppm of seeds increased crystallization rate markedly, but produced many small crystals.

Polymorphism

It is particularly interesting to note that the different fractionation processes have different requirements regarding the polymorphic state most suitable for the associated separation step.

Deroanne (1976) in his detailed study, has shown that the dry fractionation process using a rotary filter for separation requires the crystals to be in the β^1 state. This is because the β^1 crystals agglomerate successfully into the large aggregates that give good filtration. β crystals, although the ultimate particle size may be larger, do not agglomerate so easily and therefore present themselves to the filter as numerous individual crystals with bad filtration properties.

We know that palm oil requires an unusually long time for the α to β^1 transformation, 30-40 minutes being quite usual. The crystallization times used in the dry process are however of the order of 6-24 hours and α phase would therefore not be expected. The HLS process (Koslowski, 1975), however, is unusual in requiring α phase crystals. In this process the oil is crystallized from an equal volume of isopropanol containing about 5% water. On cooling, the crystals separate as a suspension of spherulites 2-3 mm in diameter in the upper layer with little dissolved olein, whereas the lower layer contains olein and solvent. Separation is effected by decantation and must take place within 2 hours, before phase transition can occur. It is probable that the relatively high stability of the phase in this system is due to some association of the isopropanol in the crystal lattice.

The conventional solvent fractionation process may be expected to give the most stable phase i.e. either β or a mixture of $\beta + \beta^1$.

It is interesting to note that the two major glycerides of palm oil have different phase tendencies. Thus POP (24 - 28% of the oil) is β stable, whereas POO (18 - 20% of the oil) is β^1 stable.

Other factors affecting crystallization

1. *Solvent type*

The following solvents have been used for fractionation of palm oil.

(a) None – in the absence of an added solvent, it is useful to consider the liquid glycerides as the solvent.

(b) Hexane – a non-polar solvent.

(c) Acetone, 2-nitropropane, isopropanol + water, isopropanol-acetone mixture and others. These solvents have varying degrees of polarity.

2. *Impurities*

The non-triglyceride components of the crude oil will affect the fractionation process in various ways.

Natural gums inhibit crystallization and make filtration more difficult. Both effects reduce the yield of 'olein'.

Free fatty acids

Free fatty acids interact with triglycerides to give eutectic mixtures and in consequence affect the 'quality' of the olein. Thus Loncin (1958) showed in 1958 that increasing ffa up to 8% caused softening in consistency. Above 8% the firmness increases again.

Bernardini (1973) found that a palm oil containing 3-4% free fatty acids gave an olein of 9°C cloud point when fractionated from hexane solution. On deodorising and bleaching, the cloud point rose to 11-12°C, and this did not occur if the fractionation was carried out with a neutral bleached oil. He considered that the change was due to some glyceride rearrangement during processing at 200°C.

An alternative explanation however might be that the free fatty acids interacted with some of the more saturated glycerides so that they remained in solution during the crystallization step. This effect would be lost on the removal of the free acids on neutralisation of the olein, and therefore the cloud point would be raised.

Our own results in Table 1 show the effect of palm oil fatty acids added to palm oil on the solids content as determined by NMR. They are compared with results from Jacobsberg and Oh (1976).

Table 1 Effect of fatty acids on solids content of palm oil

					Results from Jacobsberg	
Temp °C	Oil I	Oil I +5%	Oil II	Oil II + 5%	Oil at 0.3%	Oil Mixture at 4.3%
15	42.5	39.8	36.3	33.8	46.9	42.3
20	-	-	-	-	34.5	26.0
21	29.1	27.2	21.3	19.9	–	-
25	19.7	18.0	13.2	11.0	23.9	17.8
30	12.0	10.1	6.7	6.1	14.0	12.5

It will be seen that Jacobsberg obtained a much greater effect. However her level of 4.3% fatty acids was obtained by mixing two oils, one of which had been allowed to hydrolyse to a high level of free fatty acids. There would therefore also be an admixture of diglycerides, causing an additional depression of the solids content.

Monoglycerides

The level of monoglycerides present in crude palm oil even of relatively high free fatty acids is usually no more than about 1%. At this level significant effects on crystallization have not been reported. However, Koslowski (1975) reports a monoglyceride content of 5.5% associated with a free fatty acid of 9% and at this level he obtained inhibition of crystallization. Another effect of the monoglycerides together with free fatty acids is that they will increase the solubility of water in the crude oil. Water will have an effect on the solubility of glycerides in solvents, particularly the polar solvents, at quite low levels. It therefore seems important to dry crude oils efficiently before fractionation.

Diglycerides

The proportion of diglycerides present in crude palm oil is significant in its effect on crystallinity. It will depend on the extent of hydrolysis of the crude oil before processing. Thus an oil of 5% free fatty acid may be expected also to contain 8-9% of diglycerides.

Diglyceride contents of 6-8% are usual in palm oil although lower contents of 3-4% may be encountered in special grades such as Lotox. Diglyceride contents of this magnitude are found even in fresh unbruised fruit manually extracted.

The effect of diglycerides is twofold. Loncin (1958) showed that they are capable of forming eutectic mixtures with triglycerides and they will therefore reduce the proportion of high melting glycerides or stearin fraction obtained in a chosen fractionation process. Loncin's eutectic mixture contained about 12% whereas Moran obtained a eutectic at 20% diglyceride (Taylor, 1976).

Our own results, for palm oil diglycerides added to palm oil triglycerides purified by silica column chromatography are shown in Table 2.

Table 2 Effect of diglycerides on solids content of palm oil triglycerides

% Diglycerides	Solids content at 21°C
0	30
5.4	30
13.0	24.5
20	16.5

The second effect established for the diglycerides is their influence on the polymorphism. Depending on the cooling conditions and the types of seeding crystals present, palm oil will normally crystallize in the α form, transforming readily to the β^1 form or in some instances to a mixture of $\beta^1 + \beta$. It has been shown that diglycerides slow down the rate of transformation of the α phase into the β^1 phase (Berger, 1975). Although crystallization processes employed in fractionation are usually slow enough for this transformation to be complete by the time the separation of the solid is undertaken, the rate of transformation may affect the shape and size of the crystals obtained and hence the ease of filtration.

It has been established by Persmark (1974) that the α to β^1 transition time is very dependent on the temperature at which the fat is being held.

The results in Table 3 were obtained in our laboratories by cooling from 70° to 0° rapidly, then warming to T_2, the temperature of measurement. Palm oil diglycerides were mixed with purified palm oil triglycerides.

Table 3 α Lifetime in minutes

	% Diglycerides			
T_2	0	6.5	13	20
0	5	17	32	49
5	11	26	40	55
10	16	18	29	27
15	8	12	16	13
20	5	7	11	11

In consequence of the uncertainties introduced by the non-triglyceride constituents of crude palm oil, suppliers of fractionation equipment may recommend the use of partly refined oil as the input, and one supplier provides figures indicating the increase in yield of olein and in throughput available through the use of degummed or degummed/neutralised oil.

Such processing does not reduce the diglyceride content of the oil, in fact the concentration will be slightly increased by the removal of the other constituents.

In practice local considerations other than the efficiency of fractionation may determine the extent of prior treatment. Among these considerations are the processing facilities available, the requirements of the transport system, and the type of fraction or end use intended.

Fatty acid composition

The influence of normal variations in composition on the fractionation process is considerable. It will be most readily appreciated in relation to the glyceride composition stated in its simplest terms as in Table 4.

Table 4 Glyceride types of palm oil

	%	mpt of typical member
S_3	7	66°C
S_2U	49	38°C
SU_2	38	19.8°C
U_3	6	5°C

Two general observations can be made. The proportions of glycerides of very high mpt and of truly liquid character are quite small. The percentage of S_2U is interestingly high in relation to cocoa butter substitutes.

If a change of 1 unit in iodine value represents a change of 1 olein into 1 saturated acid then this would change the ratio of S_2U/SU_2 from 49/38 to 50/37, and might be expected to result in a reduction of about 1 part in 50 in the yield of olein. However a difference in iodine value of 4 units can result in a difference in solids content of the palm oils of 8% as in oils I and II in Table 1. In a commercial situation where the olein fraction most easily commands a premium the difference in yield resulting from iodine values of 50 as against 55 could be vital to profitability. Results relating yield to saturated acid content for the HLS (isopropanol) process are given in Table 5 (Koslowski, 1975). These effects on yield are rather greater than would be expected on the basis of the above argument.

Table 5 Effect of saturation on olein yield

Saturated fatty acids in crude oil (%)	Single stage liquid fraction yield (%)
46	77.5
48	72.5
50	67.5
52	65.5
54	61

Clearly the selection of oils for fractionation within the normal limits of variation is economically important if a high olein yield is desired.

Glyceride interactions

The mixture of glycerides present in palm oil is too complex for their phase behaviour to be capable of accurate prediction. However a number of binary mixtures of glycerides of interest have been studied. Rossell (1967) in his extensive review makes the general point that the difference in melting point of the two components governs the melting behaviour of the binary mixture. Differences greater than 30°C result in incomplete solid solutions and in monotectic (ie. a eutectic which is 100% of one component)

phase diagrams. When the difference is less than 20°C there is often solid solution over a wide range of compositions but eutectics may be present. Some examples of the behaviour of relevant binary mixtures are listed below.

Solid Solution	SOS/POS
Eutectic	POS/POP
	PPO/POP
Intermolecular or *'pseudo' compound*	OPO/POP
	SSO/SOS
Eutectic	Distearin/Tristerin at 15-20% Distearin
	Monostearin/Tristearin at 50/50
	Distearin/Monostearin at 70% Monostearin

In summary, therefore, the most common behaviour in glyceride pairs is solid solution or the formation of eutectics (or monotectics). However, 2 glyceride pairs are known to form 'pseudo' compounds, and it is known that this behaviour is transmitted to natural oil blends in which those glycerides are major constituents.

In complex mixtures the situation is less predictable, but it may be permissible to conclude that the main effect in fractionating palm oil is that a proportion of the higher melting glycerides will be dragged into the olein fraction due to eutectic formation.

The pseudo compound effect could result in a higher than expected proportion of OPO in the stearin fraction. OPO is however, a very minor constituent of palm oil (about 1%) and no such effect has been observed by Deroanne (1976) in his detailed analysis of palm oil crystallization.

Separation of solid and liquid phases

Three main techniques for phase separation are in use.

1. Filtration This applies to both the dry fractionation processes and to solvent processes. In the latter instance additional processes are required to remove the solvent.

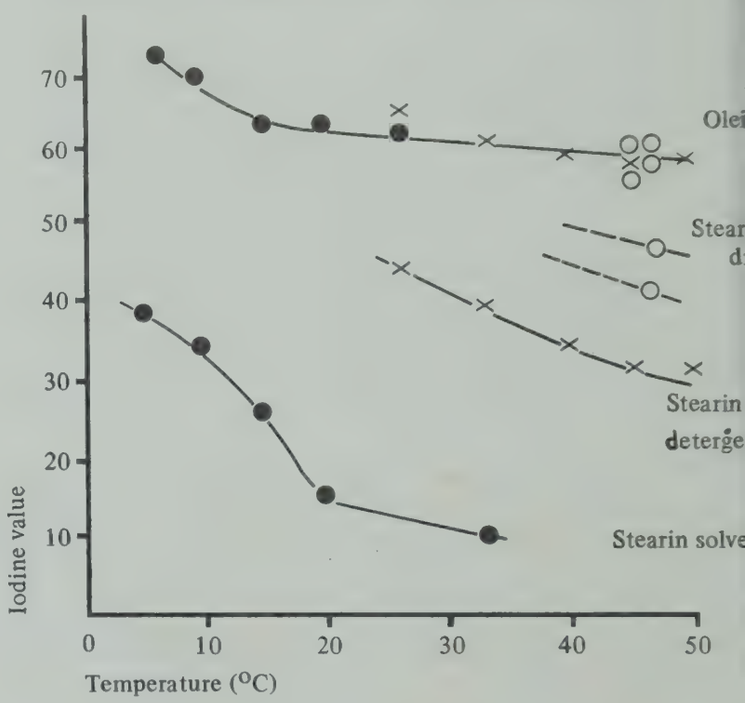
2. Detergent wetting of the solid phase after crystallization followed by centrifugation.

3. Decantation of the solid phase held in suspension in a solvent.

The main commercial processes use the first or the second method. The composition of the two phases is determined by the crystallization process and the factors affecting crystallization already described apply to a large extent whether or not a solvent is used. The separation technique does not in itself affect the composition of the phase, except for the degree of contamination of one phase with another.

This effect is very easily appreciated from Coenen's results (1974) showing the iodine value of palm oil fractions from the various processes (Figure 3), as related to the temperature of fractionation. It will be seen that the iodine value of the olein is the same for all three processes. On the other hand, the stearin iodine value varies widely, indicating different extents of occlusion of the olein phase. The most saturated stearin is obtained from the solvent process, next comes the detergent process, then the dry process using a filter press, and finally the dry process using a vacuum filter. Clearly the yields of olein and stearin will vary according to the perfection of the separation process.

Figure 3 Iodine value of palm oil fractions as a function of crystallizing temperature and process.



Criteria for evaluating the quality of fractions

This review will not deal with aspects of oxidative stability of fractions except to say that the fractionation process will almost certainly give rise to some increase in oxidation values, and there are some indications in the literature of different degrees of oxidation from the different processes (Jacobsberg and Oh, 1976; Bek-Nielsen and Krishnan, 1976) related to the type and amount of treatment of the oil involved.

The analytical characteristics of oleins and stearins produced by the various commercial processes have been assembled in Tables 6 and 7 from publications and the manufacturers' technical literature. In practice they will clearly vary according to the operating conditions of each fractionation. The original oils had iodine values of 52-55.

The iodine values for the oleins in Table 6 indicate little difference between them. If a low yield of olein is acceptable, a somewhat more unsaturated olein can be obtained, as in the Durkee process.

These figures therefore support Coenen's conclusion in this respect. The lower section of the table indicates that only interesterification, by increasing the proportion of tri-unsaturated glycerides, enables an olein of very different properties to be obtained. This additional process naturally also results in a much more saturated stearin.

Table 7 gives characteristics of the starins corresponding to the oleins of Table 6.

Table 6 Oleins

Process	Type	Iodine value	Cloud point*	Yield (%)	Cold test
Bernardini (1971)	Solvent Hexane	61	8-9	70-75	24 hrs at 19°C
HLS (Koslowski, 1975)	Solvent Isopropanol	63	5-7	62.5	3 days at 18°C
Durkee (Thomas & Paulica, 1976)	Solvent 2-nitropropane	68	-	48	-
Tirtiaux	Dry	61	6	58	7 days at 19°C
De Smet (Athanassiadis, 1976)	Dry	59	5-8	60	18°C (AOCS)
α - Laval	Detergent fraction	60	7	80	5 days at 20°C
α - Laval	Detergent fraction after inter-esterification	78.3	-2	40	3 days at 12°C
HLS	Solvent isopropanol after trans-esterification	80	-	65	-

*Cloud point – temperature at which first crystals appear on cooling at 2°C/min.

Table 7 Stearins

Process	Type	Iodine Value	Melting point (°C)	Yields (%)
Bernardini	Solvent Hexane			
	1st stearin	28	50	15-20
	2nd stearin	52	-	10
HLS	Solvent Isopropanol			
	1st stearin	38	45-50	37.5
	2nd stearin	47	30-34	-
Durkee	Solvent 2-nitropropane			
	1st stearin	13.6	60	8
	2nd stearin	45	37	44
α - Laval	Detergent stearin	28	54	20
Tirtiaux (Bek-Nielsen & Krishnan, 1976)	Dry	44	44	42
De Smet	Dry	44	45-50	40
	Detergent after inter-esterification			
	1st stearin	15.5	58.5	20
	2nd stearin	43	50.5	40
	Isopropanol after trans-esterification	5	62	35

The first and second stearins refer to the two hard fractions from a two-stage fractionation process. Clearly the first stearin taken off by crystallising at a fairly high temperature is very saturated. As indicated by Coenen the two 'dry' processes produce a high yield of stearin of fairly high iodine value, indicating the occlusion of significant proportions of the olein fraction.

What can be said about the criteria of quality of olein tabulated? The cloud point cannot be determined with great precision, and is strongly influenced by a very small proportion of high melting glyceride. The cold test, i.e. temperature at which the olein remains clear for several days, is probably a more useful criterion, and especially when the olein is intended to be used in a salad oil blend.

A more detailed discussion of criteria would require first a definition of the purpose for which the olein is to be used before choosing the criterion. Our own practice, before using palm olein in shortenings is to prepare blends to standard solids content and then determine whether the price of the olein makes the formula competitive with that using another liquid oil. Having arrived at a decision on this basis, variations in deliveries can be assessed adequately by the iodine value.

The same argument can be applied to the assessment of stearins for foods use – iodine value and melting point may be sufficient for most purposes. However, the recent publications on fractionation processes by Deroanne and Jacobsberg make good use of DSC curves for describing the separated material, and where this equipment is available, it provides efficiently a great deal of information, particularly when the requirement is for comparative information.

Fatty acid composition as a criterion

Some fatty acid compositions of original palm oil and its fractions are available in the literature. Since there is little published information about the repeatability of the processes, the figures should be examined with caution. Tables 8 and 9 below collect together the contents of palmitic, oleic and linoleic acids of the palm oils and the oleins from the literature. (Other component acids did not change much and are omitted). The composition of the stearins has also been omitted for simplicity and because, as previously stated, it is subject to the adherence of variable proportions of olein.

Table 8 Main fatty acids of olein (without solvent)

Fatty acid	Tirtiaux process (Bek-Nielsen & Krishnan, 1976)		Taylor (1976)		α-Laval* detergent	
	P.O.	Olein	P.O.	Olein	Oil	Olein
16 : 0	42.5	39.6	42.7	39.5	46	40.7
18 : 1	40.6	42.2	40.3	43.0	37.2	41.7
18 : 2	10.4	11.6	9.7	10.7	10.1	11.4

*Private communication
The first and second process, which are identical in principle but carried out in different plants, times and places, give very similar oleins.

Table 9 Main fatty acids of olein (solvent fractionation)

	Hexane Bernardini		I.P.A. HLS Process		IPA/Acetone Anadik process (Kassabian, 1974)	
C16 : 0	41.6	35.4	44.9	34.3	44.0	32.1
C18 : 1	35.2	39.9	40.7	51.1	40.0	46.0
C18 : 2	12.2	16.2	19.7	12.0	9.4	16.3

Table 10 Differences between olein and original oil

	Without solvent		Detergent	With solvent		
	Tirtiaux	Taylor		Hexane	IPA	IPA/Acetone
C16 : 0	-2.9	-3.2	-5.3	-6.2	-10.6	-11.9
C18 : 1	+1.6	+2.7	+4.7	+4.7	+10.4	+ 6.0
C18 : 2	+1.2	+1.0	+1.3	+4.0	+ 1.3	+4.9

These results indicate that the use of solvents produce a greater enrichment in the unsaturated acid content of the olein than the 'dry' processes and therefore somewhat at variance with Coenen's conclusion about olein.

The effects are made still clearer if we tabulate the differences for the main fatty acids of the varieties of oils and their oleins as in Table 10.

It is apparent that the olein from the detergent process shows greater differences from its original palm oil than do the other two 'dry' processes. Since the crystallization processes are essentially the same, the explanation probably lies in the rather higher saturated acid content of the original palm oil used. Examination of the three solvent fractionations gives some indications of selectivity. Hexane appears to be capbale of enhancing linoleate in the olein. Isopropanol, on the other hand, seems to select oleic rich glycerides at the expense of palmitic rich glycerides. The mixed solvent IPA-acetone selects for linoleate, at the same time rejecting palmitic rich glycerides. Kassabian (1974)

has suggested that the linoleic acid enrichment is a useful measure of the efficiency of a fractionation process. The present comparison indicates that there are advantages in considering changes in all the three main fatty acids.

It should be emphasised that this comparison is based on only few results. It has however, shown the possible existence of some selectivity by the different solvents. This possibility could be of great practical value, and should merit a thorough investigation.

Glyceride composition of fractions

The most valuable information that could be obtained about the fractions would be their glyceride composition. To date the only detailed study is that of Deroanne *et al*, (1976) who determined the glyceride composition of fractions taken from a Tirtiaux type crystallization at a number of temperatures between 36 and 20°C. His results should be generally applicable to all crystallizations without solvent, including therefore the α-Laval and de Smet procedures. They may also apply to some extent to solvent processes at high concentration, although obviously the temperatures of crystallization would be different.

Deroanne concluded that:

1. One could not expect to get pure glycerides from a crystallization without solvents. The crystals obtained were always a function of the intersolubility of the glycerides and at any one temperature mixed crystals were obtained.

2. The crystallization process was dynamic and dissolution of some glycerides, resulting in a 'demixing' of existing mixed crystals, occurred at 26.5° and 21°C.

3. The crystallization rate was a function not only of the unsaturation present but also of the position of the fatty acids in the molecule.

(a) Thus SSS, S_2U, SU_2, UUU crystallize in that order except that lower than expected percentages of SSU + USU are crystalline above 33.5°C. These groups crystallize fast below 33.5°C.

(b) Some linoleic glycerides crystallize to a greater degree at a given temperature than the corresponding oleic glycerides, e.g. PLP > POP, OLP > LOP > OOP.

This attributable to the greater linearity of L than O in the crystal lattice, allowing easier packing in mixed crystals.

(c) Asymmetric glycerides crystallize preferentially (from mixed crystals more readily perhaps.)

In relation to 3 (c), however, it has been noted by Knoester *et al*. (1972) that phase transitions of asymetric glycerides are slower. Deroanne concludes that although the palm oil glyceride composition is complex, essentially the crystallization process can be looked at as one of a mixed crystal separating from a solvent (the liquid glycerides mixture).

Having dealt with many of the technical factors that influence a fractionation process, I would like briefly to offer some views on the application of palm oil fractions. I think that the simplest way to look at many of the potential uses of palm oil fractions is to start with palm oil itself. This is a general purpose oil, whose main applications are in margarines, shortenings and frying. If we find technical problems in one or other of these applications, it is worth looking to see whether these problems are eased by using a palm oil fraction. For example if the trisaturated glycerides cause undesirable consistency in margarine, limiting the percentage of palm oil that can be used, will a fraction from which the highest melting glycerides have been removed be more advantageous? Are there frying uses where a somewhat more liquid product than palm oil is preferred? In that case a specified olein fraction may be suitable. Are there shortening formulations in which palm stearin provides a suitable hard stock in place of hydrogenated vegetable oil, and is it cheaper? The question of the cost and cost balance of a formulation is always very important in relation to the choice of ingredient. Will the advantages of fractions result in premium prices which more than offset the cost of fractionation?

The exception mentioned relates to the specialised fractionation of palm oil to obtain a mid fraction rich in symmetrical monounsaturated glycerides and suitable for cocoa butter extenders. When this is successfully done, it renders the fraction usable in an area different from those covered by straight palm oil, and enables much higher prices to be obtained for it. While this area is obviously therefore commercially attractive, it is a specialised product in a specialised market of limited size.

One final comment is that I look forward, within a few years time, to the application of fractionation to palm oil from Melanococca hybrids having an iodine value of 70. I believe products of great practical interest will result.

References

Alfa-Laval Technical literature. Tumba, Sweden.

Athanassiadis, A. (1976) Refining and segregation of palm oil.. *Pap. pres. Malays. Int. Symp. Palm Oil Proc. Mark., Kuala Lumpur.*

Bek-Nielsen, B. and Krishnan S. (1976) Refining and fractionation of palm oil. *Pap. pres. Malays. Int. Symp. Palm Oil Proc. Mark., Kuala Lumpur.*

(07878)

Berger, K.G. (1975) Uses of palm oil in the food industry. *Chem. Ind.*, 910-913.

Bernardini, E. (1973) The new oil and fat technology. Rome: Technologie, 760pp.

Bernardini, M and Bernardini E. (1971) Fractionnement, frigélisation et décirage des huiles et graisses alimentaires. *Rev. Franc. Corps Gras.* **18**, 439-443.

Coenen, J.W.E. (1974) Fractionnement et interestérification des corps gras dans la perspective due marché mondial des matières premières et des produits finis. I. Fractionnement. *Rev. Franc. Corps Gras,* **21**, 343-349.

Deroanne, C (1976) In: *Proc. Symp. Belg. Filtr. Soc., Brussels.*

Deroanne, C., Wathelet, J.P. and Severin, M. (1976) Etude de la structure des triglycérides de l'huile de palme fractionnée. II. Evolution de la crystallisation des triglycérides lors du refroidissement de l'huile de palme en vue de son fractionnnement par le procédé Tirtiaux. *Rev. Franc. Corps Gras,* **23**, 27-32.

Jacobsberg, B. and Oh, Chuan Ho (1976), Studies in palm oil crystallization *J. Amer, Oil Chem. Soc.*, **53**, 609-617.

Kassabian, R. (1974) *Pap. pres. Amer. Oil Chem. Soc. Meet., Philadelphia.*

Knoester, M., de Buijne, P. and van den Tempel, M. (1972) The solid-liquid equilibrium of binary mixtures of triglycerides with palmitic and stearic chains. *Chem. Phys. Lipids,* **9**, 309-319.

Koslowski, L. (1975) *Grasas y Aceites,* **26**, 95.

Loncin, M. (1958) Influence des glycérides partiels sur la plasticité des matières grasses. Cas particulier de l'huile de palme. *Oléagineux,* **13**, (1), 33-37.

Mullin, J.W. (1961) Crystallization. London: Butterworths.

Persmark, U. (1974) *Pap, pres. Int. Soc. Fat Res. Co Conf., Milan.*

Rek, J.H.M. (1973) In: Functional properties of fats in foods (ed. J. Solms). Zurich. Forster.

Rossell, J.B. (1967) *Adv. Lipid Res.*, **5**, 353.

Taylor, A.M. (1976) The crystallisation and dry fractionation of Malaysian palm oil. *Oléagineux,* **31** (2), 73-79.

Thomas, A.E. and Paulica, F.R. (1976) Solvent fractionated fats. *Chem. Ind.*, 774-779.

Tirtiaux, F. Technical literature. Fleurus, Belgium.

Weisser, H., Kasar, T. and Loncin, M. (1975) *Fette Seif. Anstrichm.*, 77, 480.

Oil Palm Market Review

A Report by the Marketing and Industrial Economics Department, Tropical Products Institute
Received 1st September, 1977

(Note: All production and trade statistics are in metric tons, i.e. in tonnes of 2,204.62 lb).

World production of palm oil attained another new record level in 1976 at 3.32 million tonnes, an increase of 13.5% on 1975 and a continuation of the high rates of growth which have been evident since 1973. However, as predicted in the last bulletin, output of palm oil in Malaysia (Peninsular Malaysia and Sabah) showed an increase of only 10% in 1976 compared with the spectactular increases of 23% in 1975 and 27% in 1974. This was due to drought during the first few months of 1976. However, production has been forecast to reach 1.6 million tonnes in 1977 which would represent a return to the trend set in 1974 and 1975. In the medium term, production is expected to rise to about 2.43 million tonnes by 1980. Amongst the other major producers of palm oil, Indonesia and the Ivory Coast both recorded increases of over 20% in 1976. This places the Ivory Coast as the world's third-ranking producer of palm oil after Malaysia and Indonesia, and just ahead of Zaire, a position which seems likely to be maintained in the foreseeable future, with annual production expected to be around 236 thousand tonnes in 1980.

Table 1 World production of palm kernel and palm oils (thousand tonnes)

	1972		1973		1974		1975		1976	
	Oil Equivalent*	(Kernels)	Oil Equivalent*	(Kernels)	Oil Equivalent*	(Kernels)	Oil Equivalent*	(Kernels)	Oil Equivalent*	(Kernels)
Palm kernels										
Nigeria	127	(270)	109	(231)	143	(305)	139	(295)	136	(290)
Sierra Leone	25	(53)	22	(46)	21	(45)	24	(52)	25	(54)
Sabah	7	(14)	6	(13)	9	(20)	8	(16)	12	(25)
Peninsular Malaysia	64	(137)	73	(155)	90	(192)	109	(233)	129	(275)
Angola	6	(13)	6	(12)	6	(12)	6	(12)	6	(12)
Cameroon	27	(57)	28	(60)	28	(60)	28	(60)	19	(40)
Benin (Dahomey)	24	(51)	31	(65)	31	(67)	33	(70)	40	(85)
Indonesia	28	(59)	30	(64)	35	(74)	38	(82)	41	(87)
Ivory Coast	11	(24)	11	(24)	18	(39)	17	(36)	19	(40)
Mexico	14	(30)	8	(17)	6	(12)	14	(30)	14	(30)
Togo	5	(10)	3	(6)	3	(7)	4	(8)	6	(12)
Zaire Rep.	49	(105)	41	(87)	36	(77)	35	(75)	33	(70)
Other	184	(392)	192	(409)	199	(423)	202	(429)	209	(444)
World Total	571	(1,215)	559	(1,190)	626	(1,333)	657	(1,397)	688	(1,464)
Palm oil										
Nigeria	460		430		485		470		510	
Sabah	72		73		88		130		140	
Peninsular Malaysia	657		740		942		1,135		1,250	
Angola	70		40		40		40		40	
Cameroon	58		60		60		60		60	
Benin (Dahomey)	39		44		47		47		35	
Indonesia	269		289		334		370		450	
Ivory Coast	93		99		146		140		176	
Zaire Rep.	180		185		174		165		170	
Others	317		337		340		366		487	
World Total	2,216		2,297		2,656		2,923		3,318	

*Converted at 47% oil content

Sources: FAO Production Yearbook
FAO Monthly Bulletin of Agricultural Economics and Statistics

(07878)

Exports of palm oil rose by 9% in 1976 to reach 1.89 million tonnes. Exports from Sabah remained at their 1975 level, but despite the slow-down in the rate of increase of production in Peninsular Malaysia, a 17% increase in exports was achieved. Indonesia recorded a modest increase of about 8% in palm oil exports, but the other main producers, Ivory Coast and Zaire, both saw a drop. Purchases by the main importing countries rose by only 2% over 1975, the main feature being a substantial fall in imports by the United States. This downward trend is continuing and it is through that total imports of palm oil into the United States in 1977 are not likely to exceed 270 thousand tonnes, which would represent a further fall of 30% compared with 1976. This drop in imports reflects a significant drop in the price of soyabean oil in relation to palm oil during 1976. Although lobbying by the US soyabean and cottonseed industries to restrict palm oil imports has continued, the US Secretary of Agriculture assured Malaysian palm oil producers on his visit to Asia in June 1977 that the US will not place any duty or quota barriers on palm oil imports into the United States.

Table 2 Exports of palm kernels and oil and palm oil from the main primary producing countries (thousand tonnes)

	1973		1974		1975		1976[p]	
Palm kernels and oil	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil
Peninsular Malaysia	–	66	–	92	–	109	–	124
Sabah[b]	13	–	20	–	25	–	25	–
Nigeria	137	40	185	39	173	19	263	20
Sierra Leone	38	3	25	9	29	10	22	11
Cameroon	12	–	26	–	12	–	12	–
Benin	–	22	–	17	–	16	–	22
Indonesia	39	7	28	17	32	14	26	21
Ivory Coast	22	–	39	–	29	–	28	1
Zaire	–	33	–	34	–	28	–	23
Total	261	171	323	208	301	196	375	221
Total in oil equivalent[a]	294		360		338		397	
of which kernels in oil equivalent[a]	(123)		(152)		(141)		(176)	
Palm oil								
Peninsular Malaysia		725		812		1,035		1,207
Sabah[b]		73		88		128		128
Benin		6		12		14		17
Indonesia		263		281		386		405
Ivory Coast		56		102		114		95
Zaire		70		62		55		40
Total		1,193		1,357		1,731		1,892

[a] Converted at 47% oil content

[b] Figures for 1976 include Sarawak

[p] Preliminary

Sources: FAO Trade Yearbook
Oil Work Weekly

Table 3 Imports of palm kernels and oil and palm oil into the principal importing countries (thousand tonnes)

	1973		1974		1975		1976[p]	
Palm Kernels and oil	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil
France	18	22	18	18	12	22	9	15
West Germany	34	17	58	34	42	17	50	21
Netherlands	122	18	149	24	98	41	137	35
United Kingdom	35	79	45	57	75	64	88	65
United States	–	46	–	66	–	72	–	68
Total	209	182	270	199	227	215	283	204
Total in oil equivalent[a]	280		326		321		338	
of which kernels in oil equivalent[a]	(98)		(127)		(107)		(133)	
Palm oil								
France		57		56		50		65
West Germany		152		133		210		193
Italy		57		54		51		60
Netherlands		160		147		186		190
United Kingdom		244		223		206		242
Canada		20		16		41		55
India		52		53		18		21
Iraq		71		120		116		125
Japan		100		115		108		154
United States		176		200		442		352
Total		1,089		1,117		1,427		1,457

[a] Converted at 47% oil content
[b] Preliminary

Sources: FAO Trade Yearbook
Oil World Weekly
Trade reports of individual countries

Palm kernel production showed a modest increase of 5% in 1976 to reach 1.5 million tonnes, or 688 thousand tonnes in oil equivalent terms. The only country to show any significant rise was Peninsular Malaysia, whose production gain of 42 thousand tonnes represented over 60% of the increase in total production.

Revisions in the 1975 export statistics given for palm kernels and palm kernel oil in the last issue show that exports of both products dropped slightly in 1975, their combined exports reaching 338 thousand tonnes in oil equivalent terms, a decline of about 6%. However both kernels and oil saw a recovery in 1976 to levels higher than those recorded in 1974. Nigeria was solely responsible for the increase in kernel exports with a rise of 50% over 1975. The increase in supplies of palm kernels available for export was matched by larger purchases by importers, the Netherlands, West Germany and UK increasing their imports by 40%, 19% and 17% respectively. However the downward trend of imports into France has continued. Imports of palm kernel oil into the principal importing countries fell by 5% to 204 thousand tonnes in 1976, decreases being recorded in most countries.

The upward trend in palm oil prices which was maintained throughout the latter half of 1976 continued during the first five months of 1977. However, sharp reversals were registered in June and July under the influence of downward movements in the Chicago soyabean oil futures market caused by an improvement in the outlook for the new US soyabean crop. Price levels still remained substantially above those recorded in June and July of 1976. Movements in the price of palm kernel oil have shown much the same pattern as palm oil. Palm kernel prices rose steeply through 1976 and up to May 1977 when they reached a peak of US $425 per tonne. However, they then suffered the same fate as palm oil and palm kernel oil, falling in June and July.

(07878)

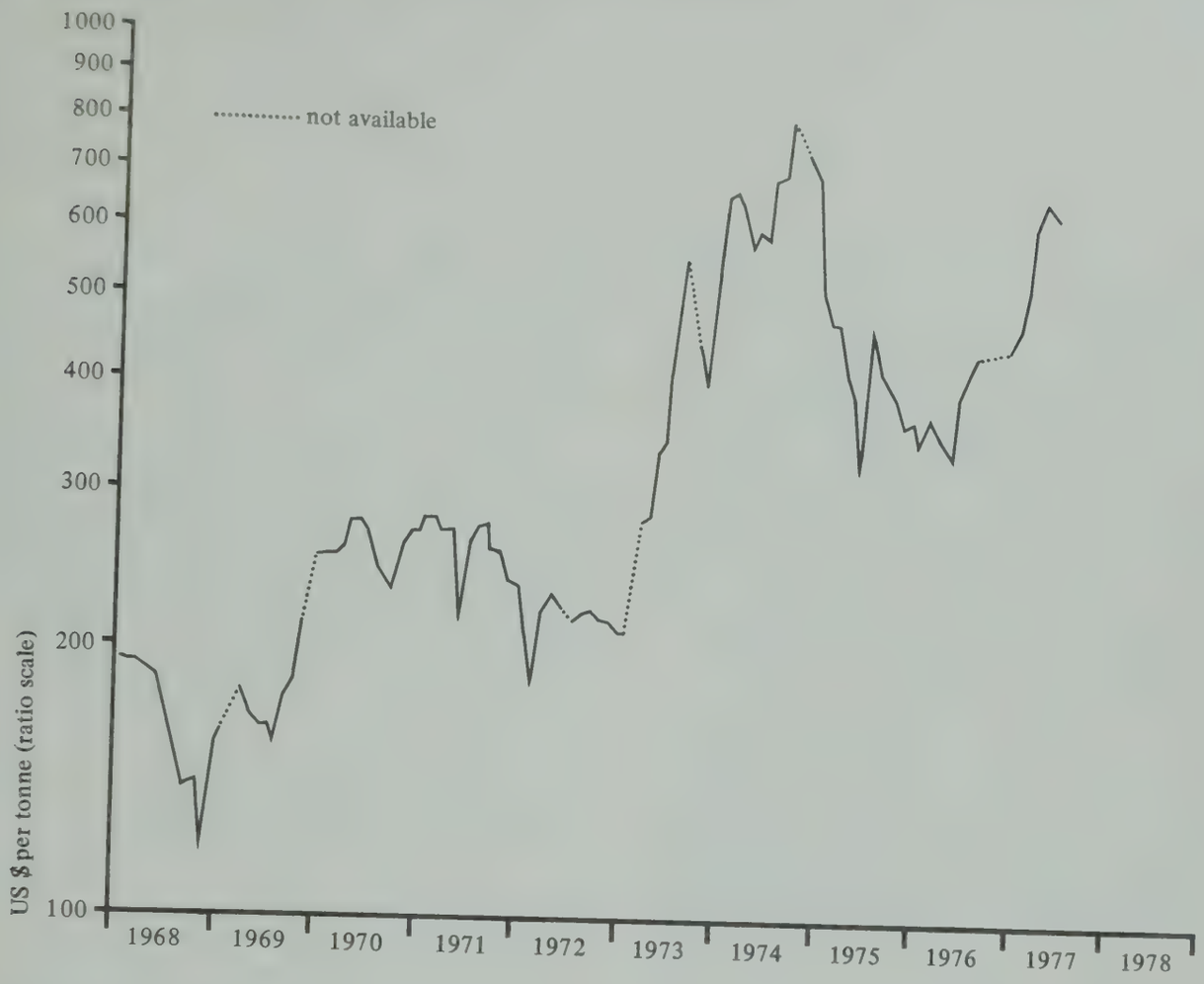
Table 4 Mid-month prices of palm oil, pam kernels and palm kernel oil (US $ per tonne)

	1975 Average	1976 Average	1977						
			January	February	March	April (mid-month)	May	June	July
Palm kernels									
Nigerian, cif N Europe ports, cash-on-arrival terms	207	228	318	320	360	420	425	370	300
Palm oil									
Malaysian, 5% ffa, cif Continent/UK	420	404	463	509	590	n	664	640	n
Malaysian/Sumatran (resale), cif Continent	398	415	465	512	595	640	'667	623	n
Palm kernel oil									
West African, cif UK	438	329	521	n	n	n	n	n	n
Malaysian, cif UK	564	523	555	580	725	810	785	750	n

n nominal

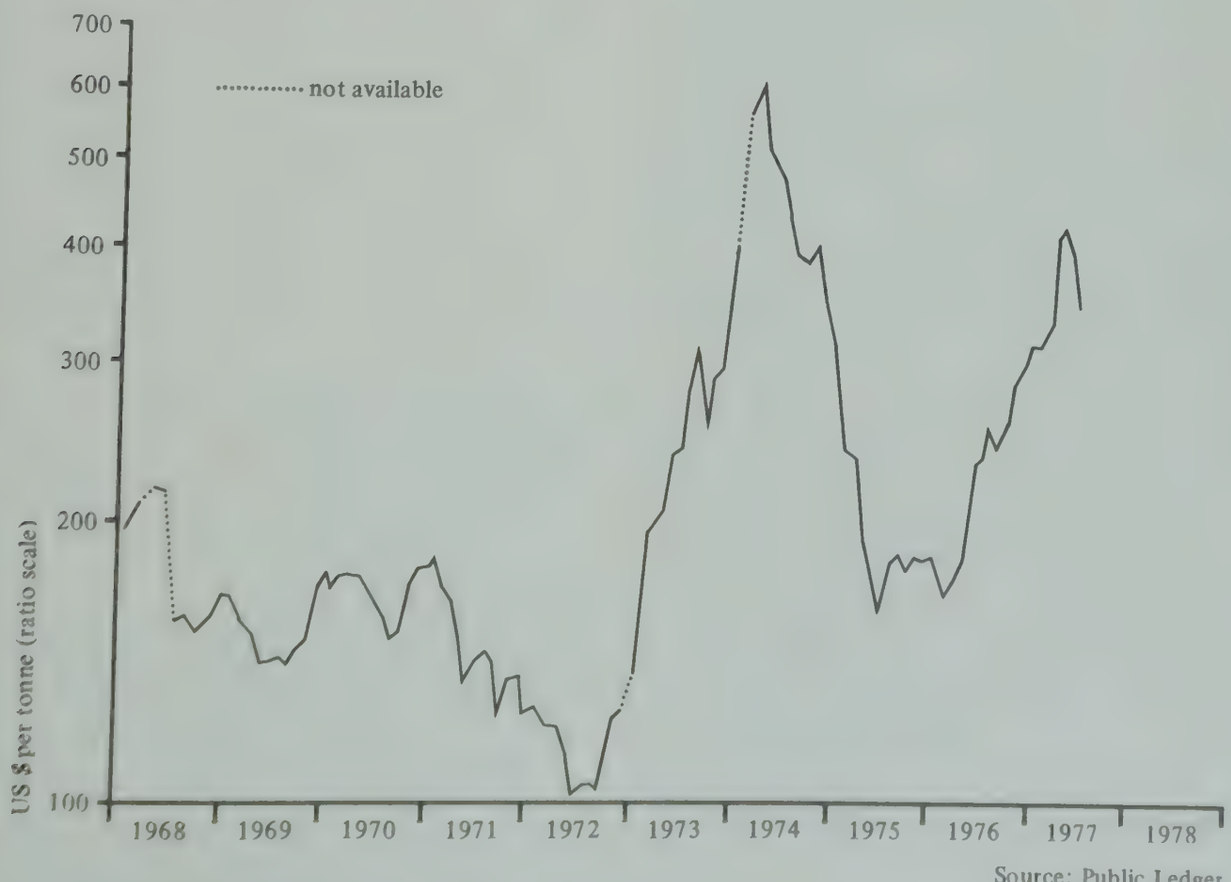
Source: **Public Ledger**

Figure 1 Vegetable oils: Palm oil – Malaysian 5% c.i.f. London Market
(End of month price)



Source: Public Ledger

Figure 2 Oilseed: Palm kernels c.i.f. London Market
(End of month price)



Source: Public Ledger

OIL PALM RESEARCH. R H V Corley, J J Hardon and B J Wood (editors).
DEVELOPMENTS IN CROP SCIENCE, Vol. 1.
Amsterdam: Elsevier Scientific Publishing Company, 1976.
Pp. xviii + 534, 21 half-tone plates, 130 tables, 54 line drawings. Price Dfl. 130.00, US$ 49.95.
ISBN 0 444 41471 1.

The main object of this volume, according to the editors, is to provide critical and reasonably comprehensive reviews of research approaches, achievements and needs in the oil palm field. This is accomplished in 35 self-contained chapters written by 23 specialists in various aspects of oil palm research.

The book is primarily concerned with pre-harvest research; oil technology and end-use are dealt with only briefly, reflecting the proportion of past research effort. However, the editors point out that the importance of the latter aspects are now being realised with particular reference to end-use research on which the future markets for the crop depend.

Thirty-four of the chapters are distributed between seven sections covering biology, breeding, mineral nutrition, agronomy, pests, diseases and technology. Chapter 35 forms an eighth section with the somewhat misleading heading 'Future developments in oil palm culture', since it also contains a sub-section dealing briefly with uses of palm oil. However, this sub-section is particularly concerned with the possibilities of widening end-usage in the future by breeding programmes and in particular by hybridisation with *Elaeis oleifera*, the American oil palm, to produce fruit yielding a more liquid oil which is higher in unsaturated acids than conventional palm oil. A concern that the breeding programme should be related to the *type* as well as the *quantity* of oil required by the user is encouraging.

The volume is well produced on good quality paper and the 21 half-tone plates are also, for the most part, of very good quality. The subject index is adequate. Printing errors are few, but it is noted that the respective organisations to which Corley and Wood are attached have become transposed on the title page.

Although by no means comprehensive, and notably lacking in a detailed review of oil palm nutrition work in Malaysia, the volume is a valuable up-to-date survey of the field and can be highly recommended to those who wish to acquire an appreciation of the present state of research over the various aspects of the oil palm industry and of current thinking towards its future emphases.

JAC

(Reprinted from *Trop. Sci.*, 1977, 19 (1)).

THE OIL PALM. C W S Hartley, London: Longman Group Limited, 2nd Edition, Published, August 1977.
Pp. xviii + 806, 83 half-tone plates, 19 colour plates, 102 line drawings. Price (UK only) £25.00.
ISBN 0 582 46809 4.

This is a completely revised edition of the first comprehensive text book with world-wide coverage to be written on the oil palm. Since the first edition was published in 1967, the oil palm has developed faster than any other tropical crop, necessitating extensive revision of the texts.

A review will appear in the next issue of *Oil Palm News*.

General

AN INTERNATIONAL SOCIETY FOR THE PLANTING PROFESSION

A special interview with Nigerian Agricultural Extension Officials. Arlin, K.C., *Planter, Kuala Lumpur,* 1976, **52**, 25-28.

A visiting group of Nigerian agricultural extension officials in Kuala Lumpur recently urged the Incorporated Society of Planters to initiate the early formation of an International society for the planting profession.

The officials had spent 8-10 weeks in Malaysia studying the oil palm industry, under a Nigerian government's study tour programme sponsored under the auspices of the country's oil palm project assisted by the World Bank.

The World Bank project aims at assisting Nigerian smallholders to replant up to 50,000 hectares of wild oil palm groves with high-yielding material of selected progenies. Each identifiable (nuclear) family hopes to replant up to 10 hectares under this scheme.

Of some 3 million acres under oil palm in Nigeria, the overwhelming portion comprises wild and semi-wild palms. Groves planted with selected material accounted for only a very small percentage of the total area under the crop (which grows wild in Nigeria).

Nigerians consume up to75% of the crude palm oil extracted from these groves - it is used as the country's traditional cooking medium.

In Malaysia, the Nigerian group observed the working of both the private sector of the industry and officially sponsored land development schemes (FELDA). They also visited the Malaysian Agricultural Research Institute (MARDI) and other research establishments.

The Nigerian visitors expressed the view that, through the publication of research findings and the holding of technical conferences and meetings on an international scale, the Malaysians were successfully communicating their prowess to the outside world, as regards the oil palm industry.

But, the scale of co-operation could be still further increased if such conferences were organised more frequently and in other centres besides Malaysia.

The Incorporated Society of Planters as a leading organisation of the planting profession, could take the initiative in this direction, especially regarding:

(a) the organisation of more frequent meetings and conferences, preferably at different national venues by rotation, if feasible, to bring about closer rapport among professionals in the planting industries everywhere:

and

(b) the establishment of a well and truly international society of the planting profession, especially to bring together members of the planting industries in the developing countries.

PROSPECTS FOR THE DEVELOPMENT OF THE OIL PALM INDUSTRY IN THE ECAFE REGION

Anon;. *Asian Industrial Development News,* 1973, **10**, 15-16.

To date, the oil palm industry has been developed on a large scale only in Indonesia and Malaysia. Traditionally, rubber and coconut have been the tropical agricultural industries in the region. However, in view of the lower income derived from these industries, there has been a strong case for diversification, and the oil-palm industry suggests itself as a suitable alternative. The oil-palm's yield of oil per hectare is the highest, being of the order of 4 tons, as against other oil-seeds and coconut (on average less than 2 tons). The oil-palm industry also provides employment for the landless and unemployed, as it is a labour-intensive industry.

The 1970 figures of world consumption of fats and oils show a per capita consumption of 22 to 24 kilogrammes in the developed countries, 13 to 16 in the centrally planned economies of Europe, and 5 to 8 in the developing countries of Asia, Africa and Latin America. In terms of production, the world total was estimated to be 41 million tons in 1970, a figure which is expected to increase to 55 million tons by 1980. The oil-palm products, namely palm-oil and palm kernel oil, are expected to increase at the rate of 8.5% and 6.2% respectively by 1980.

Papua New Guinea has recently joined Malaysia and Indonesia, as a large scale producer and is planning eventually to produce 50,000 tons palm-oil per annum. Initial planting has also taken place in India, Sri Lanka and Thailand. These countries are likely to be engaged in commercial production in the foreseeable future.

In 1972 AIDC organised a Consultative Mission on the Oil-palm Industry as requested by the Ministerial Meeting of the second session of the Asian Conference on Industrialization, which was held in September 1970. One of the important recommendations of the Mission was that a world market survey should be commissioned for oil-palm products, with the assistance of UNDP funds.* This is urgently called for, in view of the phenomenal growth of the industry in the region, and the fact that the livelihood of thousands of people depends on it. The substitution and interchange-ability of fats and oils and also the growing threat of synthetics make it imperative that a detailed investigation be made of the commercial and technical considerations leading to substitution and of the marketing patterns and end uses in importing countries. The possible diversification of uses with the introduction of advanced technology also needs to be studied in depth, and practical solutions found in the best interests of the producing countries.

*(This has now been carried out and a report will be issued by the International Trade Centre, Geneva - Editor).

PNG'S OIL PALM PROJECT - 'BIGGEST IN THE WORLD!'

Anon., *Pacific Islands Monthly,* 1977, **48**, (2), 49.

The world's biggest oil palm project is to be established at Popondetta in Papua New Guinea's Northern Province.

The K35 million project is to be managed by the Commonwealth Development Corporation (CDC) and involves the development of a 4,000 ha nucleus estate and the settling of 1,400 small holder families on 5,600 ha under oil palm surrounding the estate. The nucleus estate company will commission a 60-tonne-per-hour factory to process the output of both its own estate and the smallholders. Each smallholder family will be settled on a block allowing 4 ha to be planted to oil palm and a further 2 ha for housing and gardening.

The CDC investment is K11 million while the smallholders' project is being financed by a K 9.1 million long-term low-interest loan from the World Bank, the first loan made by the Bank to PNG without an Australian Government guarantee.

SOUTH SULAWESI (INDONESIA) TO CONDUCT SURVEY ON POSSIBLE PALM OIL CULTIVATION

Anon., *The Co-community,* 1976, **6** (23), 4.

The Indonesian Times of December 14, 1976 reported that some officials of the land-use service of the South Sulawesi Agrarian Directorate are exploring the possibility of cultivating palm on 17,000 ha of land at Sabang, Masamba, Wotu and Mangkutana sub-districts. If this land is found suitable for oil palm it will be exploited by the State-owned plantation of Sulawesi-Maluku PNP. 28. South Sulawesi is one of the major coconut producing regions of Indonesia.

MALAYSIA'S OIL PALM GOAL: DOUBLED OUTPUT IN 5 YEARS

Decourcy, J.S. (U.S. Agricultural Attaché, Kuala Lumpur), *Foreign Agriculture,* 1975, **13**, 5-7.

Malaysia plans to maintain its leading position in the world oil palm industry by increasing acreage by 44% and output of palm oil by more than 100% within the next 5 years.

By 1979 Malaysia expects to have 1.8 million acres planted to oil palm, yielding 2.4 million long tons of palm oil. Over the next 5 years, the annual rate of new planting of oil palm is expected to average 110,000 acres per year, and the average annual increase in palm oil production is forecast at 265,000 tons during the same period.

Increasing emphasis is being placed on production of higher quality crude palm oil, and on facilities for further refining of crude palm oil to encourage wider industrial end utilization of palm oil both at home and abroad.

Steps are being taken to maintain consistent high quality of crude and refined Malaysian palm oil in transit between production areas and overseas markets. Modern tank trucks, improved roads, new port areas, modern bulk storage complexes, and new ocean tankers are being put into service to expedite the movement and preserve the quality of the products.

Malaysia also plans to establish a palm oil exchange to achieve greater control over merchandising of palm oil.

Given continued price incentive, favorable weather, an expanding supply of skilled labour for plant pollination (the improved varieties of oil palm are relatively poor self-pollinators), and reduced migration from rural to urban areas, Malaysia should be able to sustain the upward production trend of 15-20% annually over the next 5 or more years.

Peninsular Malaysia exported 799,860 tons of palm oil in 1974, compared with 713,322 tons in 1973 – an increase of 12%. Malaysian exports benefited from the generally tight market situation and correspondingly higher prices in major consuming countries. The main destinations of Malaysian palm oil for 1974 in order of importance were Singapore, the Netherlands, United States, United Kingdom, Iraq, and Japan.

Both the public and private sectors of Peninsular Malaysia are pursuing impressive programs to improve, expand, and construct new infrastructure facilities to keep pace with the rapid expansion of the palm oil industry. New highways, port facilities, and bulking plants are being built – largely with public funds – in remote areas where huge tracts of land are being developed for oil palm planting.

Through tax incentives, the Government is encouraging increased palm oil processing, including refining, bleaching, fractionation, and end product manufacture. Such product will be increasingly exported as future processing capacity is added.

DEVELOPMENT IN OIL PALM INDUSTRY IN MALAYSIA

Harcharan Singh Khera, *Planter, Kuala Lumpar,* 1976, **52** 55-59.

The development of the oil palm industry in Peninsular Malaysia may be divided into three stages.

The first stage occupied 1875 to 1916. The period witnessed the introduction of oil palms in Singapore, increased Government experiments concerning the suitability of oil palm cultivation in Malaysia and the planting of oil palm in Malaysia for decorative purposes.

Although the oil palm was introduced in 1875 and its economic possibilities realised, it is strange that it remained only an ornamental plant for many years. It was not until 40 years later, by which time the word's consumption of vegetable oils and fats had increased to such an extent as to demand additional supplies, that attempts were made to cultivate the oil palm on a plantation scale. It was probably a coincidence that oil palm seeds came to Malaysia about the same time as rubber and also by the same route. Although Malaysia was the largest world producer of rubber by 1916, the oil palm was yet to be grown commercially.

In 1917 oil palm seeds were planted in the Tennamaran Estate which became the first commercial oil palm plantation in Malaysia. This marks the beginning of the oil palm industry in Malaysia.

The second stage comprises a long period beginning with the commercial planting in Malaysia in 1917 and ending in 1961. This was an exciting period – a period when the oil palm industry gradually increased its importance and laid the foundation for its rapid 'take off' in the sixties. The second commercial oil palm plantation, also in the Kuala Selangor district, was developed at Elmina Estate. The estate was first opened up in 1919 and the first 40 acres planted in 1920. A total of 570 acres were planted in 1920-22, and a total of 1,010 by the end of 1923. It was not until 1926 that there was a marked increase in the area planted with oil palm. The transition was slow. By 1925, 8,000 acres had been planted with the crop and this increased to 50,000 acres by 1930 and 63,000 acres 3 years later. By the end of 1940, the area under oil palm was 77,000 acres, and Peninsular Malaysia was exporting palm oil at the rate of 51,000 tons per annum – 12% of the world output. From late 1941 to late 1945 Malaysia was under Japanese occupation. This period increased the neglect of the oil palm industry in the country and the destruction of many of the expensive factory installations on the oil palm estates. With the return of peace, efforts were directed at rehabilitating the industry first, and then at extending the area under oil palm.

The third stage arose from the need for diversification. The declining prices of rubber in early sixties and the pessimism about future prices brought the question of diversification to the forefront again. In 1961 Malaysia embarked on an intensive agricultural diversification programme and the crop which has achieved the most notable success since then is oil palm. Within a relatively short period, the oil palm industry has become an important sector of the Malaysian economy in terms of its contribution to the national output, income and employment. Since 1966, Malaysia has become the leading producer and exporter of palm oil, and in 1974, it accounted for over 65% of the world's exports of palm oil. The widespread popularity of the crop in the estate sector and the heavy emphasis on oil palm in the new land development schemes are due to the expected long term profitability of oil palm compared to rubber.

However, the rubber industry has played and will continue to play a unique and dominating role in the economy of Malaysia. Although agricultural diversification has repeatedly been emphasised, unfortunately it has been handicapped by the limited number of other suitable and profitable crops for cultivation in Malaysia on a commercial scale. This, together with the distinct advantage Malaysia already enjoys in rubber and palm oil production, seems to make it inevitable that the future development in agriculture will continue to place considerable reliance on these two perennial crops.

SUPPLY-RESPONSE ANALYSIS OF MALAYSIAN PALM OIL

Yee Yuen Loh, and Tan Bock Thiam (Faculty of Agriculture, University of Malaya, Kuala Lumpur), *Planter, Kuala Lumpur,* 1975, **51**, 499-505.

(Malay summary, 9 lines)

The supply response of Malaysian palm oil from 1959 to 1972 was estimated using linear statistical models. Oil palm acreage rather than output was used as the dependent variable. Factors such as price of palm oil, price of rubber and oil palm yield were employed as the independent variables incorporated into the models. The results showed that the total cumulative oil palm acreage and the replanted acreage were not responsive to palm oil prices, while the newly planted acreages were responsive. The results also indicated that every dollar increase in the 3-year weighted moving average of the previous year caused new planting to increase by 40.22 ha. The fact that the total cumulative acreage and replanted acreages were not price responsive was not entirely unexpected. As the oil palm industry started only around 1920, the area which exceeds 33 years in the period of analysis was relatively low compared with the total acreage of the crop. Hence, only a small area was available for replanting. Another important factor was that replanting involved some kind of sacrifice. It meant that input capital was needed during replanting and the current income from the palmes must be foregone. In addition the non-responsiveness of replanting to price might have been due to many other factors. Replanting of oil palm for the last two decades was carried out primarily in

private commercial estates, which aimed at maximising long-run investment by maintaining a steady and high rate of production. They followed a long-term planting programme irrespective of the price level as long as the price level prevented running at a loss. Another factor was that oil palm trees have to be replanted when they reach a certain age, (usually 30-35 years old) partly because of the physical difficulties involved in maintaining and harvesting the tall palm trees.

New planting refers to the opening of new land, including the replacement of old rubber trees. It responded well to the palm oil price. Increase in new planting was contributed mainly by two sectors, namely, the private commercial estates and the public estates (government land development schemes like FELDA, RISDA, FELCRA, etc). In private estates, large acreages of land under old rubber were being planted with oil palm. Public estates, especially FELDA schemes, developed large areas of jungle land for new planting. This was especially true from 1965 onwards when the total new planting area increased from 7.547 ha in 1965 to 29,388 ha in 1972. Rubber prices have played a major role in the expansion of the oil palm industry during the last two decades. It was the decline in rubber prices that shifted the interest of rubber producers and government policy towards the oil palm industry.

Thus rubber prices continue to have a direct effect on the oil palm industry and are the determining factors for making the choice between rubber and oil palm as the price obtained for the output and subsequently the rate of return in these crops.

CONTINUOUS LINING IN OIL PALM PLANTATIONS AND CONSTRUCTION OF ROAD NETWORK

Surre, C. and Ochs, R., (IRHO, 8 Square Pétrarque, Paris, 16e, France), *Oléagineux,* 1975, **30** (12), 503-506.

(In French, English and Spanish)

The oil palm is a tree of symmetrical growth requiring as much sun as possible. For this reason, the trees should be planted in equilateral triangles, with the trees in each row half a space out of line with those in the rows on either side and with each tree at the same distance from the six trees around it. The planting layout is fully described.

A good road network is of the greatest importance because of the tonnages to be transported and the frequenty of the collection rounds in all seasons. It is preferable that the roads should be staked out to provide for continuous lining of the whole plantation. A kilometric grid is desirable but not always practicable and the use of continuous lining means that the road network can be laid out after land clearing when an accurate idea of the topography can be gained.

(This note is an up-to-date synthesis of information already published in IRHO Notes 33 and 92).

THE 'COROZO COLORADO'

Anon., *Coco y Palma, Caracas, Venezula,* 1975, **9**, 4-5.

(In Spanish)

*Elaeis melanococca** is the scientific name of a Creole palm well known as 'corozo colorado' in Venezuela. Some characteristics of two such palms known to be over 20 years old from La Esperanza plantation in the district of Taracuy are described. These two palms are less than one third of the height of similiar African palms and exhibit resistance to diseases which severely affect the African palm. The fruit of 'corozo colorado' are considerably smaller than those of the African palm. The oil from 'corozo colorado' is liquid at ambient temperature and is high in oleic acid. There are no commercial plantations of 'corozo colorado'.

(*Syn *Elaeis oleifera* – Editor).

PROSPECTS OF PLANTING *E. oleifera* x *E. guineensis* HYBRIDS IN MALAYSIA

Rajaratnam, J.A. (Chemara Research Station, Seremban, Malaysia), *Negeri Sembilan Planters' Association,* Annual Report, 1974, 27-31.

The majority of planters in Malaysia are familiar with the oil palm, *Elaeis guineensis,* (referred to as the African oil palm) but when the American oil palm *E. oleifera* (previously called *E. melanococca* or *Corozo oleifera)* is mentioned, only few have either seen or heard of it. This is because it is not grown on a commercial scale in Malaysia.

However, there are small acreages on experimental stations and the only *E. oleifera* growing in Negeri Sembilan is in Sengkang Estate where the Chemara Research Station has about 20 acres of 4-year old palms.

This palm is found in natural groves on river banks and swampy areas in the humid tropics of Central and South America extending into the Amazon Basin though it is now believed that its occurrence in the latter area has been linked with human habitation. Its growth habit and general appearance are very similar to the African oil palm except that it has a shorter trunk (similar to the dumpy palm) and the leaflets are displayed in one plane like the coconut and unlike *E. guineensis* which has upper and lower ranks of leaflets.

The fruits of *E. oleifera* are borne in bunches like the African oil palm but are generally small and there is a tendency for parthenocarpic fruits (i.e. formation of fruits without fertilization) to develop. The bunches are large and can have up to 4,000 fruits, bright orange in colour. The mesocarp oil of *E. oleifera* is similar in most respects to *E. guineensis* except for a greater proportion of unsaturated fatty acids (as reflected in the iodine value) at about 80% and 50% respectively. The shell is always relatively thick – with only one type of fruit, a dura type.

The yield of fresh fruit bunch (FFB) of *E. oleifera* and its oil content are low compared to *E. guineensis.*

E. oleifera x *E. guineensis* hybridise readily and trials with the hybrids have been undertaken in Malaysia, West Africa and South America. The yield of FFB of the hybrid is comparable to that of *E. guineensis* but the oil content of the mesocarp is believed to be between the two parent species. Two hybrid progenies of *E. guineensis* x *E. oleifera* were planted in 1959 in Twitchin Estate (KGSB), Layang-Layang as part of a Department of Agriculture exchange programme.

The results show that good yields can be obtained from the hybrids, although the yield variation from palm to palm is rather unpredictable. In these experimental studies the hybrids have been derived from unselected *E. oleifera* parent palms and the *E. guineensis* parent was a 'dumpy' dura – not always the best yielder. The extraction ratio of 17 appears reasonable since the hybrid shows all characteristics of the dura type. It is likely that a much better extraction ratio could have been obtained if hybrids had been derived from an *oleifera/pisifera* cross.

Such hybrids have already been made and planted but it is still early to draw any conclusions from the results, although preliminary observations show that extraction ratios up to 24% can be obtained. The hybrid palms are vigorous and for most morphological, vegetative and reproductive characteristics including parthenocarpy, *E. oleifera* exhibits complete dominance over *E. guineensis* in the hybrid.

Height increment of the hybrids has been much lower than that of *E. guineensis.* This is of economic importance since the height of palms affects the harvesting cost. The frond length of the hybrid appears to be longer and the lower fronds tend to droop down rather than being more vertical. It is uncertain whether this is a mechanical weakness of the frond or a genetic characteristic. This drooping of the fronds could be a hindrance in estate agricultural practices viz harvesting, weeding, manuring etc. as it would slow down the movements of workers. As a result of this, heavier pruning may be essential and this may have repercussion in yield reduction. There is also hybrid vigour for leaf area (Hardon, 1969), and it is possible that the nutrient requirement of the hybrid would be higher.

In Colombia, hybrid palms have yielded some promising results. In the 3,000 ha Coldesa estate at Tubo all the palms of *E. guineensis* were killed off by a bud rot/spear rot disease, but the hybrid palms which had been planted by accident, proved to be resistant. In addition to its disease resistance, the hybrid is also believed to be more tolerant to water logging under high water table conditions as well as being somewhat more drought-resistant than *E. guineensis.*

Thus the hybrids possess many advantages which may well outweigh their disadvantages and they could, in time, replace the existing *E. guineensis* on plantations in Malaysia.

E. melanacocca x *E. guineensis* HYBRID AND ITS IMPROVEMENT – A NEW FUTURE FOR THE OIL PALM.

Meunier, J. (Plant Breeding Department, IRHO, 8 Square Pétrarque, Paris 16e) Vallejo, C. and Boutin, D., *Oléagineux,* 1976, **31** (12), 519-528.

(In French and English. Spanish summary, 19 lines).

Elaeis guineensis hybridises easily with the American species *Elaeis melanococca*.* The progeny, usually vigorous, presents numerous morphological similarities with its American parent, however, for most of the quantitative characters, the hybrid appeared intermediary to its parents. The relatively small heightwise growth, its adaptation to marginal ecologies and above all the quality of its oil and the resistance factors are the main advantages offered by this hybrid. The IRHO have undertaken its improvement, and is now pursuing a complete selection programme which includes tests of general combining ability between origins, tests on specific combining ability between parents and genetic trials intended to solve the problems posed by this inter-specific hybridisation. Simultaneously, detailed cytological observations are carried out on the parents and the hybrids and multi-site trials enable the performance and agronomic requirements of this new crop to be studied.

*(Syn. *E. oleifera* – Editor).

Jessenia polycarpa

Anon. In: Underexpolited tropical plants with promising economic value, pp.103-105. Washington DC: National Academy of Sciences, 1975.

Jessenia polycarpa Karst. is a little-known palm which grows abundantly in some lowland areas of the Amazon region of Venezuela and Colombia. Its extra-ordinarily large and heavy fruit clusters are comparable to those of the African oil palm. The edible mesocarp constitutes almost 40% (dry basis) of the whole fruit and it contains approximately 50% oil closely resembling olive oil. Adult palms average two fruit clusters a year or 30 kg fruit from which 22 kg oil can be extracted. The yellow oil is sold in markets in Colombia and is satisfactory for food, soap or cosmetics.

Other *Jessenia* species also produce edible oil but very little is known of the genus. Information on the number of years required for the plants to mature is lacking and all species should be checked for oil production and quality. Testing the superior species under plantation conditions is essential for development and successful utilisation.

THE DETERMINATION OF THE WITHIN BUNCH COMPONENTS OF OIL YIELD IN THE OIL PALM (*Elaeis guineensis* JACQ.) I. PATTERN OF VARIATION

Ooi, S. C. and Tam, T.K. (Harrisons and Crosfield, Oil Palm Research Station, Banting, Selangor, Malaysia), *Planter, Kuala Lumpur,* 1976, **52**, 467-475.

A study of the pattern of variation of the within bunch components of oil yield was carried out with the object of improving the precision of the present method of bunch analysis. The results reveal the importance of distinguishing three regions of the bunch, namely the apical, middle and basal regions, for the purpose of sampling as these three regions contribute very significantly to variations in fruit set, mesocarp and oil content.

Breeding

PROSPECTIONS OF THE *Palmae* – A NECESSITY FOR THE IMPROVEMENT OF OIL YIELDING PALMS.

Meunier, J. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1976, **31** (4), 153-157

(In French and English. Spanish summary, 17 lines)

Explorations in the Ivory Coast, Nigeria, and Cameroon for *E. guineensis,* and in Latin America for *E. melanococca* (syn *oleifera)* give hope of new progress in oil palm improvement. However, the *Elaeis* in the Congo, Zaire and Angola should also be studied. The same applies to the coconut with regard to prospection in Malaysia, Indonesia and the Philippines. In addition, the inventary and study of the *Palmae* of Amazonia could provide new orientations in the field of oil-yielding palms. In addition to the creation of collections, prospections lead to the immediate introduction of material discovered into current breeding programmes. It is considered that an organisation like the FAO can play an important part in surmounting the difficulties arising at the level of international contacts, consignments of planting material or phytosanitary controls.

RESEARCH INTO THE CULTURE *in vitro* OF OIL PALM EMBRYOS (*Elaeis guineensis* JACQ.) XII. EFFECTS OF GROWTH SUBSTANCES AT SUPRA-OPTIMUM RATES. RELATIONSHIP WITH BROWNING OF THE TISSUES.

Rabechault, H., Ahee, J. and Guenin, G. (l'ORSTOM, 70, route d'Aulnay, 93140 Bondy, France), *Oléagineux,* 1976, **31** (4), 159-163.

(In French. English and Spanish summaries, 13 and 14 lines).

Three auxins, IAA, NAA and 2,4-D, and one cytokinin, kinetin, had a partial or total inhibitory action on the development and lengthening of the aerial part of the root of embryos extracted from the rehydrated seeds and cultured *in vitro.* NAA and 2,4-D caused an increase in the diameter of the haustorium, and in the case of 2,4-D (concentration 10^{-6}) the formation of nodules composed of dedifferentiated cells along the procambial strands. On the contrary, kinetin stimulates lengthening of the haustorium. Browning of the tissues is accentuated and the phenol content of the culture media increased gradually with the concentration in growth regulators and sharply with 10^{-4} of IAA. Kinetin provoked the greatest browning of tissues and culture media.

POSSIBILITIES FOR IMPROVING THE FATTY ACID COMPOSITION OF PALM OIL. RESULTS AND PROSPECTS.

Noiret, J.M. (IRHO, 8 Square Pétrarque, Paris 16e, France) and Wuidart, W. (IRHO, La Mé, Ivory Coast), *Oléagineux,* 1976, **31** (11), 465-474.

(In French and English with Spanish summary, 15 lines).

The study of the variability of fatty acid composition within the pure species and hybrids shows that it is possible to obtain a rapid improvement of the unsaturated fatty acid content. The correlations between fatty acids, the relationship between fatty acids and the oil yield components and the estimation of the heritability of the different fatty acids provide the basis for a selection programme for seed production and long-term improvement. The IRHO is already in a position in 1976 to supply a limited quantity of planting material producing oil with a mean unsaturated fatty acid content of 54-56%. However, the variability of *E. guineensis* is limited, and it seems indispensible to resort to hybridisation with *E. melanococca* (syn *oleifera*) to obtain almost fluid oils. A programme along these lines is now being implemented.

A RE-EXAMINATION OF LARGE-SCALE GERMINATION OF THE OIL PALM SEED AT NIFOR.

Odetola, A. (Plant Physiologist, NIFOR, near Benin City, Mid-West Nigeria), *Journal of the Nigerian Institute for Oil Palm Research,* 1974, **5** (19), 33-50.

The major factors that were responsible for the recent serious breakdown in the germination of extension work seeds at the Institute were examined. The problem was traced to faulty seed storage prior to the conventional heat treatment. A second important finding was that the shell thickness of the seeds had decreased over the years, leading to an alteration in the moisture imbibition characteristics of the nut. This in turn resulted in increases in the moisture levels formerly accepted as optimal for germination. The control of these factors, which has led to a restoration of the previous high standard of germination, is discussed and recommendations are made for the future.

HEAT REQUIREMENT OF OIL PALM SEEDS FOR GERMINATION. RELATION OF SEED AGE TO HEAT REQUIREMENT

Odetola, A. (Plant physiologist, NIFOR, near Benin City, Mid-West Nigeria), *Journal of the Nigerian Institute for Oil Palm Research,* 1974, **5** (19) 79-84.

Oil palm seeds that have been stored for different periods were treated for germination. In the absence of heat treatment, seed stored for up to 6 months was found to germinate earlier, faster, and better than fresh seed. A relation was found between seed age and heat requirement for the removal of seed dormancy. When heat treatment was given for 30 days, stored seed germinated better than fresh seed. Full dry heat-treatment was also found to delay the germination of stored seeds. The practical importance and the commercial significance of the findings in the large-scale germination of oil palm seeds are examined and discussed.

THE RELATIONSHIP BETWEEN THE DEGREE OF FRUIT SET AND BUNCH COMPONENTS OF FRUIT BUNCHES OF THE OIL PALM (*Elaeis guineensis* JACQ.)

Tam Tai Kin (Harrisons and Crosfield Oil Palm Research Station, Banting, Selangor, Malaysia), *Planter, Kuala Lumpur* 1975, **51**, 541 – 547.

A study based on bunch analysis results from 545 bunches from palms within a D x P progeny over a six-year period indicated that most (65.4%) of the bunches have between 50-65% fruit to bunch by weight, and fruit set rarely exceeds 70% by the normal method of assisted pollination. The following are positively and significantly correlated to fruit set: mean bunch weight, proportion of mesocarp to bunch, oil to bunch and kernel to bunch. The following are negatively and significantly correlated to fruit set: weight per fruit and the proportion of mesocarp to fruit. A significant and positive correlation between weight per fruit and the proportion of mesocarp to fruit is also observed. These results indicate that plantations should aim for the best possible fruit set on bunches, using a suitable system of assisted pollination where necessary, in order to obtain superior oil and kernel yields. It is considered more desirable to express commercial yields in terms of oil and kernel yields rather than fresh fruit bunches.

Agronomy

THE USE OF POLYETHYLENE BAGS FOR RAISING OIL PALM SEEDLINGS IN NIGERIA. I – RELATIVE PERFORMANCE OF SEEDLINGS GROWN IN GROUND BEDS AND POLYETHYLENE BAGS IN THE NURSERY.

Aya, F.O. (Nigerian Institute for Oil Palm Research, PMB 1030, Benin City, Mid-West Nigeria. *Journal of the Nigerian Institute for Oil Palm Research,* 1974, **5** (19), 7-12.

Oil palm seedlings planted either in natural or black polyethylene bags in the pre-nursery were more vigorous than controls planted in standard raised trays. After 11 months in the nursery, seedlings transplanted into ground beds from either natural or black pre-nursery polyethylene bags were significantly taller than those transplanted into small, medium, or large natural polyethylene bags. But the 'polybag' seedlings produced a significantly greater number of leaves than ground bed seedlings. The 'polybag' seedlings were also less susceptable to Blast and showed fewer losses resulting from various causes than those grown in standard ground beds. After 18 months in the field, seedlings transplanted from nursery 'polybags' showed a faster growth rate than rhose from ground beds.

FIELD PLANTING OF YOUNG OIL PALMS RAISED IN POLYTHENE BAGS (POLYBAGS)

Gah, B. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1976, **31** (6), 259 - 261.

(In French, English and Spanish).

After 8 months in a polybag nursery, the oil palm plant is 60-100 cm tall, has a girth of 15-22 cm, 6-8 functional leaves and 18-30 primary roots. At this stage it is ready to be planted in the field in the best conditions for successful growth.

The various operations ensuring speedy rooting of the young palm and an acceleration of its growth are described. For plants raised in polybags pruning is not necessary, although certain older leaves may be severed at the point of insertion of the leaflets, the cut being brushed with a special grease (Otina-C) to assist healing and ward off attack by insects. The plants must receive preventive insecticide and fungicide treatments before being transported to the field on the eve of planting out must be copiously watered to form up the earth ball and ensure a water reserve for several days.

Before planting, proper preparations must be made including levelling of the soil over a radius of 1 metre round the position of each palm. Other requirements are described in detail.

The plants have the best chance of rooting well if planted at the start of the rainy season. The hole dug must be slightly larger in diameter than the polybag and of such a depth that the palm bulb is flush with the surface of the soil to avoid overwetting which could occur if it were earthed up or baring of the surface roots if it were too low. The bottom of the bag is split open and the palm lifted vertically and placed in the hole, the bag being drawn slowly upwards while the space between the sides of the hole and the earth ball are filled with lightly tamped soil.

After planting, careful maintenance must be undertaken to keep terraces, drainage bunds and wire guards in a good state of repair.

(This advice note numbered IRHO Note 162, replaces IRHO Note 7 which dealt only with plants raised in a field nursery, a practice which is now out of date).

THE ABLATION OF THE INFLORESCENCES OF YOUNG OIL PALMS – SPECIAL CASE OF DRY ZONES

Anon, (IRHO 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1976, **31** (5), 211 - 213.

(In French, English and Spanish)

For oil palm growing, the so-called dry zones are characterised by an average annual rainfall of less than 1,200 - 1,300 mm with a long, very marked, dry season of about 3-5 months, and water deficits which can exceed 600 mm per year.

Not only are the yields reduced in such climatic conditions, but the trees suffer from the drought to a point where a mortality rate of 10 to 15 per cent can occur.

Observations made on the Pobe Station (People's Republic of Benin, ex-Dahomey) have shown that the more loaded the crowns with developing bunches, the more marked the sensitivity of the trees to drought. In these conditions ablation of inflorescences at an early age helps to protect the young trees from the effects of drought, over and above providing the usual advantages of improving vegatative development and increasing the weight of the first bunches harvested. However, each ablation is followed by a surge of bunches, and this burgeoning can provoke drought damage especially if it coincides with a very marked dry season. Ablation in dry zones should therefore be completed, when harvesting starts, by 'lightening the crowns'. This involves examining the crowns at the beginning of both the first and second long dry season after castration is stopped and, if necessary, removing a few developing bunches. This limits the bunch yield and also cuts the consumption of photosynthetic products in the first three months following flowering.

(This account of the special problem of dry zones – advice note, numbered IRHO Note 161 – follows up IRHO Note 157, which described the techniques of ablation of inflorescences, and which was briefly noted in *Oil Palm News*, 1976, No. 21).

VARIATION OF LEAF NUTRIENT CONTENTS WITH AGE OF PALM IN OIL PALM LEAF SAMPLING.

Knecht, J.C.X., Ramachandran, R. and Narayanan, R. (Research Department, United Plantations Berhad, Teluk Anson, Perak, Malaysia), *Oléagineux*, 1977, **32** (4), 139 - 147.

(In English and French. Spanish summary, 15 lines).

Mineral element composition variation of frond 17 according to the age of the palm was studied in three Malaysian plantations. The results of 3 years' samplings (1970-1972) were taken as a basis. Significant linear correlations were obtained for nitrogen and potassium, which leads the authors to suppose different critical levels in fuction of the age of the trees: from 2.78-2.30% of dry matter for N and from 1.32-0.82% for K for an age range from 5 to 30 years. For calcium, a tendency to an increase in the leaf level was observed in 2 plantations, whereas in the third the trend was in the opposite direction, the level decreasing with age; further study would therefore be necessary before any definite conclusions can be drawn. Regarding phosphorus and chlorine, no relationship between leaf level and the age of the plants could be established.

FIRST RESULTS FROM A TRIAL OF SLOW IRRIGATION ON OIL PALM.

de Taffin, G. (IRHO, People's Republic of Benin) and Daniel, C., (IRHO 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1976, **31 (10)**, 413-421.

(In French and English. Spanish summary, 14 lines).

Slow irrigation was used on oil palm in a trial set up on the Pobé Research Station in the People's Republic of Benin. Applications started at the beginning of 1973 on 9-year-old trees, using drippers discharging 8 litres/hour along one or two pipelines per row of trees. Observations showed that excellent hydrous nutrition of the palms is obtained even when the "wet bulbs" only represent 35-40% of the total volume of soil explored by the palm roots. It seems that this method of irrigation brings out the whole potential of the planting material, a yield equivalent to 30t/bunches/ha having been harvested in 1975/76. Naturally, a final judgement cannot be passed until several campaigns have gone by.

COMPARATIVE EFFECTS OF AMMONIUM AND NITRATE NITROGEN ON THE GROWTH AND MINERAL COMPOSITION OF OIL PALM SEEDLINGS IN SAND CULTURE.

Okoye, H.C. (Plant Physiologist, NIFOR, near Benin City, Mid-West Nigeria), *Journal of the Nigerian Institute for Oil Palm Research*, 1974, **5** (19), 51-62.

Oil palm seedlings were grown in sand culture at 4 levels (1, 5, 9 and 13 meq/L) each of NO_3-N, NH_4-N and NH_4NO_3-N. The treatments were applied daily or on alternate days and the experiment was sampled twice. The growth responses varied with the source and level of nitrogen and also with the age and stage of development of the seedlings. Growth was found to be in the following order: $NH_4NO_3 > NO_3 > NH_4$-N. The mineral elements content were differentially affected by the source and level of N. NH_4-N decreased Mg and Ca and increased N and P contents with very little effect on K content whereas NO_3-N had the opposite effect on Mg and Ca. NH_4NO_3 gave intermediate values but greatly enhanced K uptake. The application of nutrient solution on alternate days was more beneficial although daily uptake of N and P was highe in the latter.

FERTILIZER EXPERIMENTATION ON OIL PALM IN NORTH SUMATRA.

Ummar Akbar, Tampubalon, F.H., Amiruddin, D. (Agricultural Department SOCFINDO, Medan, Sumatra) and Ollagnier, M. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléaginaux*, 1976, **31** (7), 305-316.

(In English. French and Spanish summaries, 25 and 26 lines).

The mineral manuring programme for the SOCFINDO oil palm plantation in North Sumatra is established in the light of leaf analyses and of the results obtained in a field experimental network started in 1971 with the collaboration of IRHO. Mineral nutrition is characterised by a general deficiency in nitrogen and chlorine, accompanied by deficiencies in phosphorus, magnesium or potassium according to the situation. In a mature plantation, the application of 4 kg of ammonium sulphate per tree/year raises the leaf N levels from 2.21% to 2.54% and increases yield by an average of 49kg/bunch per tree/year (plus 51%) for the last two campaigns. The profitability of this heavy nitrogenous manuring is superior to that of a manuring reduced by half. In the same situation an extra yield of the same order was obtained by applying a phosphated manuring equivalent to 3kg of triple superphosphate per tree/year. No significant interaction between nitrogen and phosphorous had been noted. In zones very deficient in Mg (levels about 0.1%), the application of 1.5kg of Kieserite raises the levels to 0.19% and improves the yield by 41% (plus 43kg of bunches per tree/year for the last campaign). The form of the nitrogenous fertiliser is of great importance: the replacement of urea by ammonium chloride leads to a significant increase in yeild of 23% as a result of the correction of the leaf C1 levels from 0.35 to 0.45%.

Weeds, Pests, Diseases and their Control.

WHAT SHOULD WE DO ABOUT OIL PALM EPIPHYTES?

Piggott, A.G. and Piggott, C.J., (Chemara Agricultural Services, P O Box 134, Seremban, Malaysia), *Planter, Kuala Lumpur*, 1976, **52**, 354-362.

Plantation oil palms support many epiphytes, predominantly ferns. Few of these have an adverse affect on yield and removal is usually of aesthetic value only.

THE CONTROL OF *Amaranthus* spp. (L.) IN OIL PALM NURSERIES IN NIGERIA

Aya, F.O. (Agronomist, NIFOR, near Benin City, Mid West Nigeria), *Journal of the Nigerian Institute for Oil Palm Research*, 1974, **5** (19), 13-18.

n herbicide trials for the control of *Amaranthus* spp. in oil palm nurseries, mixtures containing paraquat were more effective than those without. The best control of the weed was achieved with a mixture of diuron at 2.0 lb. per acre and paraquat at 2.0ml per gallon of spray mixture. The activity of herbicides on young oil palm seedlings was dependent on the timing of their application.

SIMPLE TECHNIQUES FOR THE ISOLATION OF *Pythium splendens* BRAUN FROM NURSERY SOILS AND FROM SEEDLINGS OF THE OIL PALM (*Elaeis guineensis* JACQ.) AFFECTED BY THE BLAST DISEASE

Aderungboye, F.O. (Plant Pathologist) and Esuruoso, O.F. (Senior Lecturer in Plant Pathology, Department of Agricultural Biology, University of Ibadan, Nigeria). *Journal of the Nigerian Institute for Oil Palm Research*, 1974, **5** (19), 63-72.

Simple techniques were developed for the isolation of *Pythium splendens* Braun from diseased oil palm seedlings and from naturally-infested nursery soils. The fungus was isolated from diseased seedlings by plating infected root segments on cassava-dextrose agar (CDA) and from the soil by baiting for a period of 24 hours with young live oil palm (*dura* x *pisifera*) root discs previously immersed for 1 hour in a 100 ppm aqueous solution of pimaricin. The fungus produced distinct colonies and mature sporangia within 24 and 48 hours respectively of plating the root discs on CDA.

OIL PALM BLAST: ROLE OF INSECTS IN THE DISEASE - PRELIMINARY RESULTS

Renard, J.L. Mariau, D. and Quencez, P. (SODEPALM, La Mé, B.P. 13 Bingerville, Ivory Coast), *Oléagineux*, 1975, **30** (12), 497-502.

(In French and English. Spanish summary, 4 lines).

Recent studies on blast disease of the oil palm in the Ivory Coast reveals the role which insects can play in its occurrance. Not only insects but also microclimatic factors involving the deposition of dew on the leaves which may serve as an attractant to the insects carrying infection, may be involved.

MORPHOLOGICAL AND BIOLOGICAL STUDY OF A LEPIDOPTERON DEFOILIATING OIL PALM IN LATIN AMERICA, *Darna metaleuca* WALKER.

Genty, Ph. (Service Entomologie, INDUPALMA, Bogota, Colombia), *Oléagineux*, 1976, **31** (3), 99-107.

(In French and Spanish. English summary, 12 lines).

At the present time *Darna metaleuca* W., one of the most dangerous lepidoptera defoliating oil palm in South America, has been found in Colombia, Ecuador and Peru;

more than 80% destruction of the leaves has resulted in 62% loss of yield over 2 years. The morphology and biology of this insect are studied. The importance of the parasite complex, which should be observed carefully before any decision is taken about chemical treatment, is demonstrated. Many pesticides, even those belonging to the strongest products, have proved ineffective against this insect. Only carbaryl mixed with trichlorfon, and even better chlorfenamidine, have given satisfactory results.

CHEMICAL CONTROL OF *Imperata*

Coomans, P. (IRHO, 8 Square Pétrarque, Paris 16e), *Oléagineux*, 1976, **31** (3), 109-112.

(In French, English and Spanish)

Conditions in which chemical herbicides should be used to control *Imperata* are described. The use of mechanical equipment to eliminate *Imperata* when preparing land for planting with oil palm or coconut is only possible if the area is large enough to allow tractors to manoeuvre. It is also only economically justifiable if the *Imperata* population is dense and covers a large area. If the zones of the weed are small or inaccessible to tractors, chemical weeding is indicated. After planting, chemical herbicides should also be used even if the *Imperata* zones are large and tractors have been used in land preparation. Further dustings are likely to damage that part of the root system of the coconut or oil palm which is very close to the surface.

Methods of using the chemical herbicide 'Dalapon' before and after planting are set out in detail. Finally, there is a full description of the method of controlling regrowth.

THE I.M.U. (INTEGRATED MECHANICAL UPKEEP) CONCEPT HERBICIDE SPRAYING

Anderson, J. (Nova Scotia Estate, Teluk Anson, Perak, Malaysia), *Planter, Kuala Lumpur*, 1976, **52**, 161-171.

This section of the IMU concept deals with the application of herbicides potentially in all plantation crops, although the bulk of the work described has been carried out on oil palms, with some work in rubber. The spraying machine is an imported unit modified in Malaysia to suit local conditions and to meet the flexibility required in estate useage. It provides a means of application of herbicides at very low application costs.

REDUCTION IN LALANG WIPING FREQUENCY USING ROUNDUP

Wong Phui Weng (Monsanto Far East Limited, Petaling Jaya, Malaysia), *Planter, Kuala Lumpur*, 1976, **52**, 323-325.

Results of seven lalang wiping trials in zero to 10% shade showed that a reduction in the frequency of wiping is possible when Roundup at 1.75 fl. oz. per gallon (13.2 g/l) water is used instead of the standard chemical, lalang oil.

THE INFLUENCE OF POTASSIUM ON THE RESISTANCE OF OIL PALMS TO *Fusarium*

Ollagnier, M. (IRHO, 8 Square Pétrarque, Paris 16e France) and Renard, J. – L., *Oléagineux*, 1976, **31** (5), 203-209.

(In French and English. Spanish summary, 8 lines).

The application of increasing rates of potassium chloride greatly reduced the development of wilt caused by *Fusarium oxysporum* f. sp. *elaeidis* in oil palms in the Ivory Coast. The very strong effect on a susceptible cross was equally marked in a resistant one. The leaf potassium level which is most favourable for resistance is the same as that required for optimum production.

CONTROL OF *Cercaspora* LEAF SPOT OF THE OIL PALM. I – IN THE NURSERY.

Renard, J. – L. and Quillec, G. (IRHO, Robert-Michaux Experimental Station, B.P.8, Dabou, Ivory Coast), *Oléagineux*, 1977, **32** (2), 43-50.

(In French and English. Spanish summary, 6 lines).

The systemic fungicides Benlate and Pelt are the most effective ones against *Cercospora* leaf spot of the oil palm. Because there is a risk that resistant strains of *Cercospora elaeidis* may appear, and in view of the efficiency of fortnightly treatments it is this frequency of application which is recommended for industrial plantations.

CONTROL OF *Cercospora* LEAF SPOT OF THE OIL PALM. II – IN THE PLANTATION.

Renard, J.–L., Quillec, G. and Hornus, Ph. (IRHO, Robert-Michaux Experimental Station, B.P.8, Dabou, Ivory Coast), *Oléagineux*, 1977, **32** (3), 89-93.

(In French and English. Spanish summary, 5 lines).

Control of *Cercospora* leaf spot of the oil palm is possible in the first year of planting. As long as the treatments ar well done, better development of the plant results. In industrial plantations, this requirement necessitates strict surveillance.

AN EFFICIENT METHOD FOR INDUCING SPORULATION OF *Cercospora elaeidis* STEY. IN PURE CULTURE.

Rajagopalan, K. (Plant pathologist, NIFOR, near Benin City, Nigeria), *Journal of the Nigerian Insistute for Oil Palm Research,* 1974, **5** (19), 19-22.

Cercospora elaeidis Stey. sporulates readily on oil palm leaf decoction agar, palm leaf decoction-palm wine agar and potato-dextrose agar incorporated with palm leaf decoction after 14 days inoculation at ambient temperature. Either artificial light from a 15W fluorescent tube or natural alternation of day light and darkness favours sporulation although complete darkness did not suppress it. Only cultures raised from conidia sporulate under laboratory conditions.

INFLUENCE OF IRRIGATION AND SHADING ON THE OCCURRENCE OF BLAST DISEASE OF OIL PALM SEEDLINGS

Rajagopalan, K. (Plant Pathologist, NIFOR, near Benin City, Mid-West Nigeria), *Journal of the Nigerian Institute for Oil Palm Research,* 1974, **5** (19), 23-32.

During three nursery seasons the effectiveness of shading and irrigation was examined for the control of Blast disease of oil palm seedlings caused by *Pythium splendens* Braun and *Rhizoctonia lamellifera* Small. The results indicate that shading of seedlings particularly during the hot dry period (September-January), is most effective. Supplementary irrigation alone did not reduce the loss of seedlings due to Blast. Experimental evidence shows that the degree of infection is dependent on soil temperature and that a temperature range of 80-85^{O}F favours effective infection under natural conditions. Shading did not have any deleterious effects on general palm growth. Shading with palm fronds was more effective both on cost efficiency basis and in disease control.

STUDY OF DEVELOPMENT OF *Coelaenomenodera elaeidis* MLK. (COLEOPTERA, HISPIDAE) ON THE HYBRID *E. guineensis* JACQ. x *E. melanococca.*

Philippe, R. (IRHO Station de La Mé, Ivory Coast). *Oléagineux,* 1977, **32** (1), 1-4.

(In French and English. Spanish summary, 11 lines).

The hybrid *E. guineensis* x *E. melanococca** has very interesting characteristics; consequently it was useful to analyse the developments of *Coelaenomenodera elaeidis* on the progeny of this cross. Experiments conducted on the IRHO station of La Mé have shown a very unfavourable influence of the hybrid *E. melanococca* on the growth of this pest. Considerable mortality can be noted amongst the eggs deposited on the hybrid (39% against 76.1% on pure *E. guineensis*) and a high death rate at the level of the young lavae hollowing out galleries on the hybrid leaflets (89.1% against 46.6% on pure *E. guineensis).*

*(Syn. *E. oleifera* – Editor).

PROTECTION OF YOUNG PALMS AGAINST RATS

Anon. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1976, **31** (4), 164-168.

(In French, English and Spanish)

In the early years a young palm oil plantation can be attacked by rodents of different species according to the region; whatever the type, they gnaw more or less deeply into the stem base or cause serious wounds, which, if not always mortal, offer an entry to insects.

In the first place proper maintenance must be assured, particularly round the borders and in the circles round the young palms. As a preventive measure, wire or aluminium sheet guards are recommended, the latter having the advantage of being perfectly smooth and offering no hold to the rodents. Great care must be taken to ensure correct positioning of the aluminium guards, however, since unlike wire netting, they are not held in place by the roots of the growing palm.

Chemical control is also recommended when attacks are heavy and a detailed description of curative chemical treatment is given.

(This advice note, numbered IRHO Note 160, represents a synthesis of information already published in Oléagineux under the heading Conseils de l'IRHO, Nos. 55, 69 and 99.)

OWLS AS MAJOR PREDATORS OF RATS IN OIL PALM ESTATES WITH PARTICULAR REFERENCE TO THE BARN OWL (*Tyto alba*)

Duckett, J.E. (Kuala Lumpur Kepong Bhd), *Planter, Kuala Lumpur,* 1976, **52**, 4-15.

The extent and significance of rat control by owls is little known. Efforts to increase the levels of natural predators on estates have been confined to introducing snakes and, in a few cases, the establishment of 'cat farms' among the oil palms. Both types of predator have, however, had limited success. Snakes are themselves preyed on extensively by diurnal birds of prey, and almost all estate workers feel a deep abhorrence for them and insist on killing them on sight.

The domestic 'cat farm' set up in oil palms (Turner & Gillbanks 1974) normally flourish for a while and then experience a sudden decrease in numbers and the population disappears. This is usually associated with a baiting round carried out to deal with increasing rat populations and the cats die from a diet of rats suffering from poison effects.

Alternatively, the cats eat the baits direct as the attractants for rats in the baits are just as attractive to cats and the poison content is equally effective.

Owls have a digestive system that sets them apart from almost all other birds and it is possible to obtain a remarkably accurate knowledge of their main diet sources and the number of rats taken by a single bird in a day. The owl is also superbly developed as a nocturnal hunter of rodents, having widely spaced eyes and binocular vision, highly developed hearing organs, and is renowned for its silence in flight.

Whilst owls as natural predators can never in oil palm plantations achieve a complete control of rats, and regular baiting will always be essential for good control, they can, nevertheless, serve a very real use in slowing the rate of rat population build-up, particularly after major baiting programmes and thus assist in extending the interval between such programmes. In this respect, they have an economic value and each rat taken by a natural predator means one bait less to be used. Thus a family group of barn owls would possibly consume something in the region of 2,000 rats per year and can therefore be assessed as having an annual value to the estate equal to the cost of 2,000 rat bait, assuming that only one bait is required to kill one rat.

Amongst the natural predators of rats, owls, and in particular the barn owls, are possibly the most efficient. In view of this, every effort should be made to protect them and to provide them with suitable nesting sites as this latter factor may restrict their distribution.

The barn owl has been proved to be on the increase in Malaya and, since 1969, has graduated from being 'very rare' to being fairly regularly sighted in numerous widespread locations. It is possibly far more common than the sighted reports suggest. A detailed study of this bird and research into refinements of suitable artificial nest sites and a study of the feasibility of introducing breeding nuclei to areas where the owls do not occur could prove to be of considerable value to the oil palm industry.

Palm Oil

PALM OIL: TECHNOLOGY AND USES

Baltes, J. (D-4401 Sendenhorst, Sudtor 13, Federal Republic of Germany), *Revue Française des Corps Gras,* 1975, **22** (5), 255-260 and **22** (6), 305 - 311 (in French).

(Part I: French, English, German and Spanish summaries. 25, 20, 25 and 24 lines; Part II: French and English summaries. 11 and 11 lines).

The articles look at the palm oil industry with regard to economics, technology and uses of the final product. First the author shows the economic importance of palm oil for West Europe and especially for West Germany. Then the properties and composition of principal oils used in oil mills and special conditions of transport and storage are described. Industrial processing of palm oil is reviewed. Refining is essential for obtaining products for consumption, while hydrogenation, interesterification and fractionation are used to make particular products.

Thermal bleaching is typical for palm oil and consists of decomposing carotenoides, in order to bleach them. This stage can be associated with deodorization or neutralization by distillation. The different types of installation are explained, conditions of treatment are discussed and technical installations are shown on photographs.

In the second article, hydrogenation, transesterification and fractionation of palm oil, as well as its use and the use of its products in foods are described. The corresponding technology is reviewed. The greatest amount of palm oil is used for shortenings and margarine manufacture. Palm oil fractions are used in frying oils or cocoa butter substitutes. Several examples of such applications are given.

PALM OIL PROCESSING PLANT FOR INDONESIA

Anon., *Foreign Agriculture,* 1976, **14** (4), 14.

Indonesia plans to build a palm-oil processing plant at Gohor Lama in northern Sumatra with a loan of $11.3 million from the Asian Development Bank. Technical assistance will also be provided by the Bank to undertake a feasibility study for a development scheme for smallholders.

When the palm-oil mill is in operation in 1980, it is expected to process 125,000 tonnes of fresh-fruit palm bunches annually, from which 25,000 tonnes of palm oil and 5,000 tonnes of palm kernels will be produced each year. The palm oil will be exported, while most of the palm-kernel oil will be consumed domestically as a substitute for coconut oil. Annual net foreign exchange earnings from exports are expected to reach $6.1 million.

FRACTIONATION AND WINTERIZATION OF EDIBLE FATS AND OILS

Kreulin, H.P. (H.V.A. – Internationaal B.V., Amsterdam, The Netherlands). *Journal of the American Oil Chemists' Society,* 1976, **53** (6), 393-396.

Processes for fractionation and winterisation are reviewed. Properties of solid and liquid fractions of various fats and oils are discussed. In view of the current interest in palm oil, the operation and economics of a small palm oil processing plant, including fractionation, are described.

STEAM (PHYSICAL) REFINING DEODORIZER FOR MALAYSIAN PALM OIL

Gavin, A.M. (EMI Corporation, Des Plaines, Illinois, USA), Toeh, K.T. (Palmex Industries, Penang, Malaysia) and Carlin, G., *Journal of the American Oil Chemists' Society*, 1977, **54** (4), 312A-315A.

The production of Malaysian palm oil is expected to increase 20% per year for the next 5 years. More than a million acres have already been planted which will start to produce in the next few years. Recent plantings of new strains will produce 2,400-3,000 lb of palm oil per acre.

Palmex Industries, Penang, started to operate in August 1975, a physical refining system producing a deodorized palm oil with 0.03% FFA from crude palm oil containing 5.0%FFA. Production records confirm the feasibility of physical refining crude palm oil in Malaysia, exporting the oil to the United States and producing a quality product with a minimum of additional processing.

REFINING AND SEGREGATION OF PALM OIL

Athanassiadis, A. (Refining Department, Extraction De Smet S.A., Antwerp, Belgium), *Oléagineux*, 1977, **32** (4), 173-178.

(In English with French and Spanish summaries, 21 and 22 lines).

Palm oil is especially easy to physically refine and it is well known that this process gives a much higher yield of refined oil than does classical caustic soda refining. A complete process, of which all the details are given, has been developed, which enables refined oil of the same quality and stability as those from classical caustic soda refining to be obtained. As well as improved refining ratio (1.1 instead of 1.8 to 1.7), physical refining produces no pollution and provides distilled fatty acids of commercial quality as a by-product. In addition, segregation into two phases by winterization, provides an easy method of obtaining more than 50% of a fluid fraction which has a much higher commercial value than does the original palm oil. The article describes the different successive phases in the equipment required for this process, giving the highest yield of a liquid fraction of neutral, bleached and deodorized palm oil.

SOLVENT FRACTIONATED FATS

Thomas, A.E. and Paulicka, F.R. (Glidden-Durkee Division-SCM Corporation, Dwight P. Joyce Research Centre, Strongsville, Ohio, 4130, USA), *Chemistry and Industry*, 18 September, 1976, 779.

The underlying principles of crystallisation from solvent are discussed, namely the separation of component triglycerides with differing solubilities in a solvent arising from structural differences of components in which fatty acids differ in chain length, and in degree and type of unsaturation. Commercial processes are outlined and hard butters derived from fractionated lauric oils and from palm oil, the latter finding use as a cocoa butter extender, are described.

STUDIES IN PALM OIL CRYSTALLIZATION

Jacobsberg, B. (Tropical Products Sales S.A., 1040 Bruxelles, Belgium) and Oh Chuan Ho (CERIA, Institut des Industries de Fermentation-Institut Meurice Chimie, Technologie Alimentaire, 1070 Bruxelles), *Journal of the American Oil Chemists' Society*, 1976, **53** (10), 609-617.

Melting and crystallization behaviour of palm oil were examined by NMR, differencial scanning calorimetry and plasticity measurements. These were correlated with composition and chemical characteristics. Fractionation to high and low melting components is adversely affected by increase in FFA, diglyceride content and degree of oxidation. Hence, for oil that is to be fractionated, both hydrolysis and oxidation should be kept to a minimum. Palm oil with very low FFA content, obtained from ripe unbruised fruit, contains substantially more diglyceride than would be expected from the level of FFA present. Liquid and solid palm oil fractions manufactured in the producing countries showed large variation in characteristics, due in part to the use of various fractionation processes. Characteristics used to define the quality of palm oil are also applicable to its fractions.

THERMAL DEGRADATION OF β – CAROTENE IN PALM OIL – STUDY OF VOLATILE PRODUCTS.

Hinnekens, H. (Oléofina, Bruxelles), Gooris, A., Carlier, M. – C., Vandegans, J. and Jacqmain, D. (CERIA, Avenue Emile Gryzon 1, B-1070-Bruxelles, Belgium), *Rev. Francaise des Corps Gras*, 1976, **23** (11), 609-616.

(In French, English, German and Spanish summaries, 6, 7 and 7 lines).

In a study of the thermal degradation of β – carotenes in palm oil, a few volatile products of the unsaponifiable matter have been identified. Toluene, m-xylene, ionene and some cyclohexenyl components have been detected, but no 2, 6-dimethylnaphthalene. Reactions of degradation of β–carotene are proposed.

USE OF PALM OIL – KERNEL OIL MIXTURES FOR FOOD PURPOSES

Richert, M.–T. (Laboratoire des Corps Gras, IRHO, Gerdat, Montpellier, France), *Oléagineux*, 1977, **32** (1), 21-23.

(In French. English and Spanish summaries, 6 and 8 lines).

This study could be of interest to West African and Indonesian consumers: performance of blends of palm oil/ kernel oil under different conditions, consistency at various

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temperatures, oxidation stability, etc. The possibility of using blends of crude palm oil and refined kernel oil (in particular 50/50 blends) for food purposes as a complement to palm oil are considered.

PROGRESS TOWARDS BETTER PALM OIL TEST METHODS. I – A COLLABORATIVE STUDY OF EXISTING TEST METHODS BY VARIOUS LABORATORIES.

Yeoh, G.H. (Chemara Research Station, Seremban, Malaysia), *Planter, Kuala Lumpur,* 1977, **53**, 48-56.

Results of a recent inter-laboratory cross check exercise on currently existing test methods for some palm oil properties are presented. It was noted that reasonable agreement existed among the participating laboratories in respect of FFA, iodine value and peroxide value but agreement for other analyses, such as insoluble impurities and moisture content, were very poor. It is obvious that improving the inter-laboratory agreement demands immediate attention and standard test methods acceptable to all concerned must be formulated.

PRICE, CONSUMER ACCEPTANCE FACTORS IN OIL PALM BOOM

McGuire, Ellen V. (Foreign Commodity Analysis, Oilseeds Foreign Agricultural Service), *Foreign Agriculture,* 1975, **13** (32), 2-4, 13.

World production and trade in palm oil, a relatively low-cost commodity that is rapidly gaining consumer acceptance in shortening, margarine, and in salad and cooking oils, are projected to rise substantially during the next few years.

Outturns by 1980 are expected to be about 72% above the 2.5 million tons of 1974, and trade more than double that of the 1.4 million tons exported in 1974.

Accelerated production of palm oil resulted from extensive plantings of improved high-yield varieties of African oil palms, especially in Malaysia, Indonesia, and the Ivory Coast. Large areas of oil palms were planted in the 1960's, and are still being planted in these countries as well as in other tropical and subtropical areas of the world.

Average palm oil yields per acre from the newer high-yield varieties surpass the average yield of other oil-bearing crops. Their yield at 2 tons or more per acre is five times greater than that of peanuts – the highest oil-yielding crop among oilseeds – and 25 times greater than the yield from cotton-seed.

The rapid growth of palm oil consumption in European and Asian countries and the United States has been primarily in edible products – especially shortening, margarine, and vanaspati, and to a lesser extent in salad and cooking oils and other food products in domestic and export trade.

A factor that has favoured consumption of palm oil has been the world market price situation.

Exceedingly high prices of edible vegetable oils prevailed in all world markets from mid-1973 until the spring of 1975. As world supplies of edible oils became more plentiful in 1975 after the better oilseed harvests of 1974, prices of edible oils tended to moderate. During the period of tight world supplies, palm oil production – little affected by drought or other adverse weather conditions – continued to increase.

Palm oil prices, responding to strong world demand, increased accordingly, but not to the same extent as other preferred edible oils. During the period of exceedingly high world market prices, palm oil became 'a good buy'; and continues to hold that position today.

MALAYSIA'S PALM OIL EXPORTS UP

Anon., *Foreign Agriculture,* 1976, **14** (4), 10.

Peninsular Malaysia's exports of palm products soared during the first 9 months of 1975 and producers in the country are trying to improve operations to enable them to better serve their export markets, according to John S DeCourcy, US Agricultural Attaché at Kuala Lumpur.

One local integrated palm oil factory has introduced a more efficient method of delivering crude palm oil from isolated factories located on waterways to road tankers and bulk storage complexes. The system involves the use of barges equipped with heating units to keep the oil at a specified temperature to prevent an increase in the oil's free fatty acid (FFA) content. Previously this system of handling palm oil was available only on ocean-going tankers.

According to Malaysian press reports, a group of local palm oil refiners recently formed an association to draw up minimum standards for their products. The group aims to establish uniform descriptions and documentation to enhance overseas marketing of palm oil.

Peninsular Malaysia's production of crude palm oil during the first 9 months of 1975 amounted to 792,736 long tons, up 23% from the 644,567 tons of the same period in the previous year. Palm kernel output, totalling 161,326 tons for the first 9 months of the year, was 22 per cent above the level of the same period of 1974.

During the January-September period of 1975, Peninsular Malaysia exported 598,678 tons of crude palm oil, an increase of 9% over the corresponding period for 1974.

Exports of palm kernel oil, totalling 80,498 tons between January and September 1975 were up 25% on those for the same period of the previous year.

Sabah shipped 87,115 tons of crude palm oil during the January-September period of 1975, compared with 57,638

s in the same months of 1974. This total was 51%
ıer than in the same months of 1974. Sarawak's exports
rude palm oil were 2,438 tons in the 1975 period, up
n zero shipments in the first 9 months of 1974.

n Oil Mill Effluent

TENTIAL OF PALM OIL MILL EFFLUENT AS FEED
R GROWING-FINISHING PIGS

agalung, R.I., Chang, C.C., Toh, K.M. and Chan, H.C.
culty of Agriculture, University of Malaya, Kuala
mpur), *Planter, Kuala Lumpur,* 1977, **53**, 2-9.

o types of processed palm oil mill effluent referred to as
sor tk8 (35% palm oil sludge, 32.5% cassava root meal,
5% palm kernel cake) and *tkg* (32% palm oil sludge, 34%
sava root meal and 17% palm kernel cake, 17% grass
al), were evaluated in pigs. Both censor meals replaced
50 or 100% maize fraction in a conventional maize-
abean ration.

e rate of gain in pigs fed 50% *censor tk8* or *tkg* diet, was
atively the same, but their feed intake and feed per gain
io were significantly higher than those of the control.
100% replacement of maize by either *censor tk8* or *tkg*,
performance was significantly poorer than that of zero
l 50% censor diets. No substantial differences were
served in the carcass characteristics measured.

alysis of cost showed that it is economical to replace 50%
ize with *censor tk8* or *tkg* which gave a saving of
0.02 per pig per day in feed and a higher extra dollar
nefit of M$ 0.08 and 0.01 per kg gain, respectively.

TRACTION OF SLUDGE SOLIDS IN PALM OIL
FLUENTS

illaimuthu, J. (Industrial Patents (M) Sdn. Bhd., 111
an Pudu, Kuala Lumpur), *Planter, Kuala Lumpur,* 1976,
, 420-423.

new micro bubble flotation process mechanically removes
m oil sludge solids, clarifies the effluent and simplifies
logical treatment.

Training

The Bureau is prepared to advise management in the oil palm industry on the training of personnel. Details of the nationality, linguistic abilities and educational background of the candidate would be needed, together with the purpose for which training is required.

Information

The Tropical Products Institute has one of the world's best libraries of periodicals and works of reference dealing with the products of developing countries and photo-copies of articles dealing with the oil palm can be provided on request. Answers to technical queries concerning the oil palm can also be dealt with; certain agronomic or engineering inquiries might have to be referred outside the Institute, but the Secretary of the Bureau would endeavour to find the best source of information.

In general, no charge will be made for any of the services provided but, if in a specific instance any charge has to be made, the inquirer will be notified in advance before he is committed to any costs.

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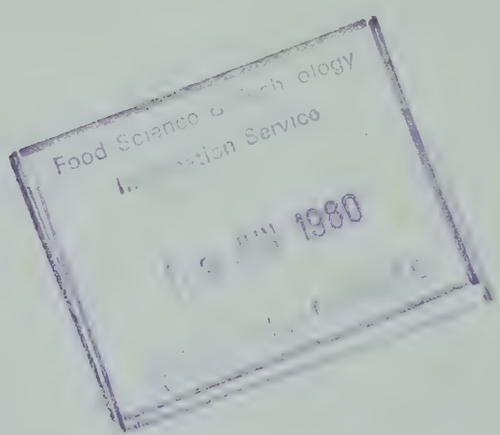

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EDITORIAL

We include in this issue the first of our 'News Item' features – 'The Oil Palm in Sierra Leone' – which it is intended to continue and develop, any items which might be included under this heading for future issues will be welcome.

Also in this issue, an article describing a village palm oil mill constructed as far as possible from local materials and in operation in the Cameroons which could well be of interest to small processors – actual or potential – elsewhere.

Kurt Berger's paper, 'Quality problems arising during transport of palm oil products', is of particular relevance where the products are to be exported.

It will be noted that major articles now have French and Spanish summaries and where abstracts are of articles originally in another language, the title is also given in the original language.

The Editor will be glad to receive articles and comments for the 24th and the subsequent issues of *Oil Palm News* as soon as possible.

NEWS ITEM: THE OIL PALM IN SIERRA LEONE

C. W. S. Hartley

Three Gables, Amberley, Nr. Stroud, Glos. GL5 5AH

Summary

This article summarises the history of oil palm product production in Sierra Leone which has been a disappointing one owing to various factors. Experimental work carried out by the sub-station of the West African Institute for Oil Palm Research (1958 to 1962) gave a first reliable indication of production potential of the planted palm in Sierra Leone.

As a result of an Institut de Recherches pour les Huiles et Oléagineux (IRHO) survey in 1966, the scheme at Gambia near Martru was proceeded with, but in 1976, the 1968 plantings yielded only just over 6 tonnes f.f.b./ha which is attributable amongst other factors to a high average water deficit from 1970 to 1977, the inclusion of concretionary soils and to fire.

However, another scheme prepared by IRHO in the Eastern Province has been more successful, with yields of 12 tonnes f.f.b./ha in 1976 of the 1968 planted area. The planted area in 1977 was 732 ha of nucleus estate plus 1,430 ha out-growers up to 1976. The total planting of this area is to be scheduled to total over 4,000 ha by 1980.

About 150 ha of imported D x P have been planted in the Eastern Province for providing funds for the Eastern Clinic at Mobai. It is hoped to extend this to 800 ha following a feasibility study.

Résumé

On trouvera dans cet article un résumé de l'histoire de la production des produits du palmier à huile au Sierra Leone qui a été médiocre en raison de divers facteurs. Grâce aux travaux expérimentaux menés par la station auxiliaire de l'Institut d'Afrique Occidentale pour les Recherches sur le Palmier à Huile (1958 à 1962), on a obtenu les premiéres données sur le potentiel de production des plantations de palmiers au Sierra Leone.

A la suite d'un tour d'horizon Institut de Recherches pour les Huiles et Oléagineux, (IRHO) en 1966, l'on a mis en oeuvre le projet à Gambia, près de Martru, mais en 1976, les plantations faites en 1968 n'ont rapporté qu'un peu plus de 6 tonnes-grapes/ha que l'on peut attribuer à un manque moyen élevé d'eau entre 1970 et 1977, l'inclusion de sols concrétionnés et aux incendies entre autres facteurs.

Cependant un autre projet préparé par l'IRHO dans la Province Orientale a mieux réussi, avec des récoltes de 12 tonnes-grapes/ha en 1976, sur la surface plantée en 1968. La superficie plantée en 1977 comprenait 732 ha de domaine central plus 1,430 ha supplémentaires jusqu'en 1976. L'on considère que les plantations totales dans cette région dépasseront 4,000 ha vers 1980.

L'on a planté environ 150 ha de D x P importés dans la Province Orientale pour créer un revenu pour la Clinique Orientale à Mobai. L'on espère agrandir cette superficie jusqu'à 800 ha aprés une étude de faisabilité.

Resumen

En este artículo se resume la historia de la producción de productos de la palmera de aceite en Sierra Leona, que ha sido decepcionante debido a diversos factores. Las operaciones experimentales realizadas por la subestación del Instituto de Africa Occidental para Investigación sobre la Palmera de Aceite, durante 1958 a 1962, dio una indicación inicial fidedigna de las posibilidades de protección de las palmeras plantadas en Sierra Leona.

Como resultado de una encuesta realizada por la IRHO en 1966, se emprendió el proyecto de Gambia, cerca de Martru pero en 1976, las plantaciones de 1968 rindieron solamente un poco más de 6 toneladas en manojos por hectárea que se puede atribuir a una elevada deficiencia media de agua de 1970 a 1977, la inclusión de suelos concrecionados y daños de incendio, entre otros factores.

Sin embargo, otro plan preparado por la IRHO en la Provin Oriental ha tenido más éxito, con rendimientos de 12 toneladas en manojos por hectárea en 1976 de la zona plantada en 1968.

La zona plantada en 1977 era una finca central de 732 hectáreas con agricultores circundantes con una extensión de 1.430 hectáreas hasta 1976. La plantación total de esta zona se ha programado para que alcance un total de más d 4.000 hectáreas en 1980.

Se han plantado unas 150 hectáreas de D x P importado e la Provincia Oriental para proporcionar fondos destinados a la Clínica Oriental en Mobai. Se espera empliar esto hast 800 hectáreas después de realizar un estudio de factibilida

Abbreviation: f.f.b. fresh fruit bunch

Introduction

Sierra Leone lies towards the western end of the oil palm belt of West Africa where the climate is becoming strongly seasonal and the rainfall during the summer months is particularly heavy. In the palm grove areas the population tends to be settled and fairly evenly spread, resulting in an open type of grove which has been called 'palm bush' or 'farmland with palms'. Only in certain areas towards the coast, e.g. the region around Matru, have denser groves (similar to the great areas of eastern Nigeria) developed.

History

Sierra Leone's history as a producer of oil palm products has been a disappointing one. Only at the very beginning of the century was there ever a significant export of palm oil, and since the early 1950s the country has imported increasing quantities. Up to the early 1970s more than 40,000 tonnes of palm kernels were exported annually, but this export has been declining, though some of the kernels are now crushed in Freetown and the two products are also exported.

Attemps to improve production have until recently been unsuccessful and this has been variously attributed to the poor price offered for fruit, transport difficulties, lack of training and interest in agriculture, and problems of land tenure and capital supply. However, the soils and climate of Sierra Leone have also presented real problems.

In 1955 a definite attempt was made to initiate a revival of interest by the establishment of a sub-station of the West Africa Institute for Oil Palm Research (now NIFOR), and areas of improved material and comprehensive fertiliser experiments were laid down there in the next few years. Unfortunately the impact of this sub-station was less than it should have been, firstly because, being at Njala, it was not sited in either the most climatically suitable part of the country nor in the larger expanses of suitable soils, and secondly because with the break-up of the West African institutes in 1962 the station passed to other administrations and the continuity of direction and purpose was lost. Nevertheless, the early results obtained were important (though unpublicised in Sierra Leone) because they gave a first reliable indication of the production potential of the planted palm in Sierra Leone.

Briefly, the experiments showed firstly that only very low yields could be expected on soils containing large quantities of concretionary gravel (plinthite), and secondly that on non-gravelly soils yields depended on the severity of the dry season two years previously and could be enhanced by correct manuring. Yields on the latter soils were, in fact close to those which can be calculated by modern methods of yield prediction.

In the early 1960s small estates were established by the Sierra Leone Produce Marketing Board but much of the land chosen had unsuitable concretionary soils. Some even more ambitious schemes were started, but being in climatically unfavourable regions and lacking finance, they were abandoned. Up to this time it appears that the Eastern Province had hardly been considered at all for development owing to its remoteness from the larger centres, though local agricultural officers were keen to encourage oil palm planting.

IRHO/IADP schemes

In 1966, IRHO carried out a general reconnaissance to locate areas for oil palm development. Not unexpectedly their workers recommended an area - Gambia - near Matru on the tertiary sedimentary sands close to a 4/ha grove plot at Bissao which WAIFOR had chosen for recording and part of which was replanted in 1962 by the Institute before its disbandment. It is of interest to record that this is an area of 'dense grove' rather than 'farmland with palms' and that this grove plot, prior to replanting, had yielded nearly 7 tonnes f.f.b./ha per annum from 1959 to 1961.

In 1968 a feasibility study was carried out and a yield of 12.5 tonnes f.f.b./ha was tentatively forecast on the basis of a detailed soil survey and rainfall data of four surrounding stations from which a mean water deficit of 300 mm was deduced. The area was found to contain some swampy land and areas of concretionary soil over outcrops of crystalline rocks (Kasila series) and these were excluded from the original design of just over 4,000 ha.

This scheme was proceeded with, but the yields have been well below expectation. In 1976 , for instance, the areas planted in 1968 were yielding only just over 6 tonnes f.f.b./ha and the younger areas even less. Examination of the climatic data and of the plantation itself has shown that the obtaining of only half the predicted yield may be attributed largely to the facts that the water deficit from 1970 to 1977 has actually averaged over 400 mm and that some areas of concretionary soil have been included. Apart from these factors, fire damage has occurred in certain years and neither fertiliser application nor havesting has been regular.

In 1966 the establishment of an estate on the banks of the Moa river near Daru in the Eastern Province where the climate is more favourable than at Gambia was also recommended. The water deficit was estimated to average 189 mm on the basis of 10 years rainfall data prior to 1966, and one of the principle soils was the Moa series, widely regarded as the most productive soil of the region. The yield forecasts were similar to those at Gambia, which was cautious considering the superior climate and soils. The scheme, which included outgrowers, was put in hand and in 1972 was taken over by the Integrated Agricultural Development Project (IADP) and supported by the World Bank. Up to 1977 a total of 732 ha had been planted as a nucleus estate and, up to 1976, 1,430 ha by outgrowers. The latter part of the scheme has been progressing steadily as far as planting is concerned, but the maintenance of an unaccountably low bunch price (Le 25 per tonne) at the Daru mill restricted the sale of outgrowers bunches to the

mill to only 11 tonnes in 1976. It is estimated that the processing of fruit by the outgrowers themselves instead of at the mill has resulted in the loss to the country of between 50% and 60% of the oil extractable from the bunches.

The Daru nucleus plantation has been more successful than the Gambia plantation in achieving yield targets. In 1976 the 1968 planted areas were yielding 12 tonnes f.f.b./ha which, as the water deficit in the 1973–74 dry season was over 300 mm, was satisfactory, and there seems no reason why in better years 15 tonnes should not be achieved. The more disappointing yields in some of the younger areas have been due to widespread fires in certain dry seasons, irregularities of fertiliser application and harvesting and, perhaps, to the inclusion of some patches of unsuitable soils.

The Integrated Agricultural Development Project now proposes to increase the outgrowers areas to a total of over 300 ha by 1980 which, with the nucleus estate and another estate of 600 ha being privately developed, will bring the area available for providing bunches for the Daru mill to over 4,000 ha.

Scheme for funding Eastern Clinic

Another interesting scheme that has been started in the Eastern Province aims at providing funds for the much admired Eastern Clinic at Mobai directed by Dr. B. M. Kobba. Several areas have been acquired from the local Chiefdoms and planted with imported *dura* and *pisifera* seed.These areas are for the most part on suitable soils in regions with dry season water deficits of about 250 mm. About 150 ha have been planted and it is hoped, following a feasibility study, to finance an extension of the project to 800 ha with, perhaps, further extensions. Some areas proposed have been found to be too gravelly, but sufficient other available areas are expected to be suitable.

Conclusions

From the limited experience of large-scale planting so far obtained in Sierra Leone it can be concluded that very careful selection of soils is required, with the rigorous exclusion of very gravelly soils, that climatic data must be viewed with caution, particularly if the data are not from the immediate vicinity or are only for limited periods, that the possibility of unfavourable periods lasting for as much as a decade cannot be ignored, and that it is of particular importance for the fulfilment of yield targets in this part of the oil palm belt that the correct timing and methods of cultivation be faithfully adhered to.

A VILLAGE PALM OIL MILL

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Summary

A low cost village palm oil mill was installed in West Cameroon with a production of 800 to 1,000 kg palm oil and 150 to 200 kg kernel per 8-hour shift. The mill can serve a village plantation of 100 to 150 ha. Optimal use has been made of local materials to reduce building and equipment costs. A boiler (120 kg steam/h) for low pressure steam is used for sterilizing fruit, drying of nuts and cleaning of drums. A novel type of digester and a modified type of clarification tank with foam and sludge trap have been installed. Two hydraulic Stork hand presses are used. Two 5 hp diesel engines are in use, one for the digester and the other for the combined unit of the water pump/nut cracker. Lists of materials and equipment are presented as well as a short description of the milling. Unskilled personnel can easily be trained to operate the mill.

Résumé

Une huilerie de palme villageoise bon marché a été installée au Cameroun occidental, assurant une production de 800 à 1,000 kg d'huile de palme et de 150 à 200 kg d'amandes par période de relève de huit heures. La huilerie suffit pour une plantation villageoise de 100 à 150 ha. Les materiaux locaux ont été utilisés au mieux afin de réduire le prix de revient de la construction et du matériel. Une chaudière (120 kg de vapeur/heure) fournit la vapeur à basse pression servant à la stérilisation des fruits, au séchage des amandes et au nettoyage des bidons. Un type original de malaxeur et un type modifié de bac de décantation muni d'un piège à écume et résidus ont été installés. On utilise deux presses hydrauliques à bras Stork. Deux moteurs diesel d'une puissance de 5.00 chx. vap. servent, l'un pour le malaxeur, l'autre pour le combiné pompe à eau/casse-amandes. On présente des listes de matériaux et de matériel ainsi qu'une description sommaire du traitement. La formation de personnel non expérimenté à la conduite de la huilerie est aisée.

Resumen

En el Camerún Occidental se instaló una Fabrica aldeana de bajo costo para aceite de palma con una producción de 800 a 1,000 kg de aceite de palma y 150 a 200 kg de semillas por turno de ocho horas. La Fabrica puede servir a una plantación de aldea de 100 a 150 ha. Se han utilizado al máximo los materiales locales para reducir los gastos de construcción y equipo. Se utiliza una caldera (120 kg de vapor/hora) para vapor a baja presión, destinada a la esterilización del fruto, secado de las semillas y limpieza de los tambores. Se ha instalado un tipo innovador de digestor y un tipo modificado de depósito de clarificación con separación de espuma y fangos. Se utilizan dos prensas hidráulicas manuales Stork, así como dos motores Diesel de 5 CV, de las cuales una es para el digestor y la otra para la unidad combinada de bomba de agua y rompedora de nueces. Se presentan listas de materiales y equipo, así como una breve descripción de la operación de la Fabrica. Se puede entrenar fácilmente a personal sin especialización para que haga funcionar la Fabrica.

Introduction

The oil palm *(Elaeis guineensis* Jacq.) is very hardy. Once it is 4–5 years old, it can survive adverse conditions such as poor maintenance, fire, defoliation, high winds or water-logging for extended periods. Diseases are in general of minor importance in areas planted with palms for the first time. Pests are occasionally a problem in Africa. Maintenance and harvesting are uncomplicated operations. Fruit production continues throughout the year and plant material of greatly improved varieties can be obtained easily from national or international centres.

In many respects the oil palm seems an ideal small holder crop. However, other tree and palm crops are more interesting to local farmers. The cultivation of the oil palm is not favoured because of the difficulties encountered in fruit processing at an intermediate scale.

Brief historic review of processing methods

The traditional method of oil extraction in Africa consists of boiling the fruit for several hours followed by pounding with a heavy wooden pestle, immersion of the resulting pulp in water, skimming off the oil, boiling the oil in a vessel followed by further skimming, and frying the oil. The oil recovery in this time and labour consuming process is 50–60%. In the past 25 years improvements have been made in small scale processing. A hand operated screw press has been developed that gives a 60–70% extraction efficiency. During the late 1950s Stork introduced an hydraulic handpress that improved efficiency to 75–85% and even over 90% when instructions on pulp preparation are followed correctly. However, a better press does not solve all the milling problems.

The Pioneer Mill introduced in the late 1940s was a first attempt in intermediate scale processing. A number of unfavourable factors adversely influenced its success such as high labour requirements, poor quality of the fruit from the wild palms, poor mill siting and too complicated machinery. Also, a mechanically improved Pioneer Oil Mill could not compete with the handpress 'backyard' operation because of its high costs.

More promising seems the Junior Oil Mill designed by Stork-Amsterdam. This mill has a throughput of 24 tonnes f.f.b./8-hour shift and can serve a plantation of about 800 ha. However, a substantial credit of around US$850,000 is needed to build such a mill and this amount of credit may be unobtainable for many village co-operative societies. Spare part supplies may present a problem as they have to be imported.

S. C. Nwanze, the late Director of the Nigerian Institute for Oil Palm Research, approached the problem of small scale processing from a different angle (Nwanze, 1965). He designed simple milling equipment using locally available materials such as petrol drums, angle iron and timber, together with an imported Stork handpress. In particular, his design of a clarification tank was successful. However, Nwanze's method of sterilization of quartered bunches is tedious; fruit must be heated before pounding; the pounding is carried out with heavy pestles and the resulting pulp has to be re-heated before pressing. A major advantage of Nwanze's type of processing is the local availability of all materials, except the press, but the main disadvantages are the thin drum plate that burns through after a few months, the labour intensity of the processing, and the high firewood requirements. It is recommended that Nwanze's publication be read in conjunction with this article.

Basic criteria in a new design of intermediate scale palm oil mill.

Basic criteria in the mill design were:

1. Mechanisation of the heavy work.
2. Simplicity of operation in view of the employment of unskilled villagers.
3. Low fuel consumption for fruit cooking and nut drying.
4. A mill that can serve a plantation of 100–150 ha.
5. The use of locally available construction materials.
6. Low construction costs.
7. Possibility for employment of men and women.
8. Maintenance by a good garage mechanic.

Description of Mbongo palm oil mill

A. Site

The first Village Palm Oil Mill was built near Mbongo Village the northern foothills of Mount Cameroon, West Africa in 1976.

B. Building

The mill building is an open shed of 9 × 24 m. The uprights are from split iron wood of about 12 cm diameter. The roof construction is from local hardwood and aluminium sheeting. One carpenter and one mate completed the building on contract within 3 weeks.

C. Layout

The layout is based on the following principles: continuous operation of equipment; minimal distances between processing steps; no crossings in the processing paths; optimal use of steam. The general layout and flow of products are presented in Figure 1.

D. Fruit reception

There are two storage places for the fruit side by side and used alternately. This prevents accumulation of rotten fruit. The roof is extended over the fruit reception area. Hardwood is used for the walls and 7.5 cm concrete for the floor. Fruit is sifted in the field to reduce the input of sand and calyx leaves.

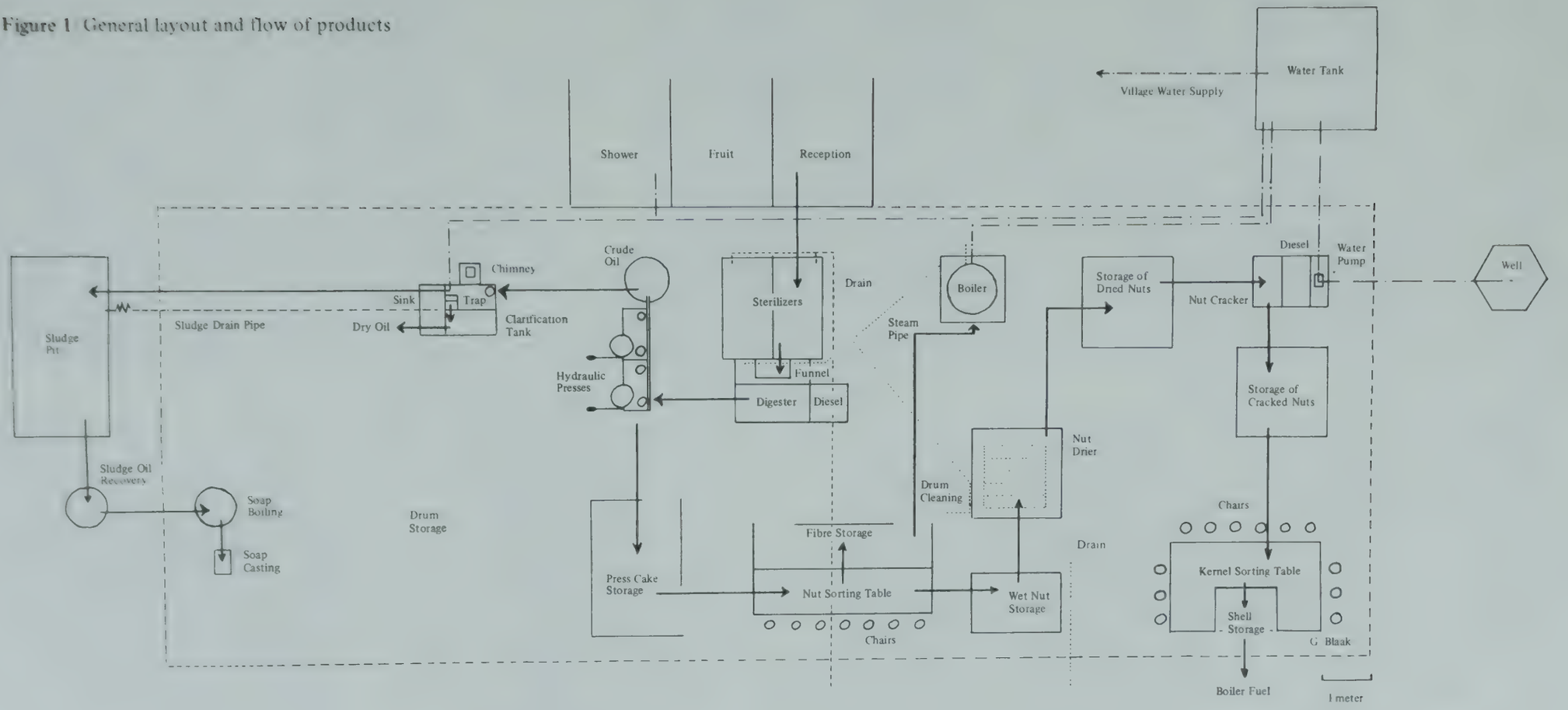
E. Sterilizers and sterilization

Two sterilizers of 100 × 200 cm and a height of 100 cm were locally welded from 3 mm steel plate. They were fitted with a hinged 3 mm steel plate cover and a perforated screen of 4 mm steel plate at 20 cm from the bottom. The two sterilizers are placed side by side near the fruit reception on 35 cm high concrete foundations and are filled with a broad shovel. Each sterilizer holds 1.1 tonnes loose fruit. The boiler, supplying 120 kg steam per hour, takes one hour to heat 1.1 tonnes fruit. Digestion can start from 1 to 2 hours later. Only a minimal steam supply is maintained during the emptying of the sterilizer and heating of the second sterilizer can commence in the meantime.

Atmospheric steam is blown under the perforated plate. This results in a very even steam distribution. Condensed steam escapes through a siphon trap. The overflow level of the trap is 2 cm above the sterilizer bottom level. The siphon trap is of 5 cm diameter pipe. The pipe can be turned downwards allowing easy sterilizer cleaning at the end of the day. No valves are needed for the traps.

Millers have the tendency to start milling too early on the first charge. It is advisable to steam one sterilizer with fruit at the end of one day to enable an early start the following day.

Figure 1 General layout and flow of products



*F. Digester**

One of the main problems in intermediate scale processing is the digestion of the cooked fruit. Small digesters are available from various companies. However, the prices range from US $15,000 to 20,000 f.o.b., which are obviously too high for many co-operative farming communities.

A horizontal type of digester was designed. A horizontal digester allows a simple design of the bearing supported shaft and power transmission. The digester kettle measures only 40 × 60 cm. Two hard steel propellers and a mixing device are mounted on the shaft. Digestion is in batches of 25–30 kg and completed in 3–4 minutes.

The inlet of the digester funnel has a platform that is attached to the upper edge of the sterilizers. The boiling hot fruit is transferred with a broad shovel into the digester. A 12 cm diameter gate at the bottom of the digester serves as an outlet for the hot pulp, which is pressed immediately. Pre - heating of pulp before pressing, as in Nwanze's system, can be omitted and results in savings in labour and fuel.

The mechanisation of the highly unpleasant pounding saves at least ten labourers in this intermediate scale mill, while the quality of the pulp is improved. Construction cost of the digester is about US$3,600. A 5 hp one cylinder air cooled SAMOFA diesel engine is used to drive the digester.

G. Hydraulic presses

Two hydraulic and hand operated Stork presses are in use. They are placed side by side. These presses can each process about 300 kg pulp per hour. They are efficient and very reliable. A good extraction of over 90% efficiency can be obtained as long as the fruit is well cooked, well digested and the pulp is pressed hot.

H. Clarification

The clarification as described by Nwanze has been modified. A kettle of 100×100×100 cm was welded from 3 mm steel plate (see Figure 2). Half of the kettle is used for clarification and the other half for oil drying. In Nwanze's system foam and sludge can pass into the oil collection receptacle. This system has been improved by constructing a foam and sludge trap between the crude oil and clean oil reservoirs. The clarification/oil drying tank is placed on a brick fireplace made from local bricks. Overheating of the clean oil is prevented provided 150–200 litres of oil are present in the reservoir, because the sludge in the clarification part of the tank cools the oil. The temperature of the oil can only rise to 100°C or slightly higher. This is just sufficient to dry the oil effectively before drum storage.

I. Steam supply

It was decided to purchase a small boiler second-hand despi its cost in view of the following advantages as compared wit individual fireplaces:

1. More efficient layout of the processing path.
2. A big saving on fuel consumption.
3. Nut drying irrespective of weather conditions.
4. Oil drum cleaning with live steam.
5. Less wear on sterilizer kettles.

The boiler has vertical flame pipes and produces 120 kg steam per hour. It is fired by firewood, press cake fibre and shells of oil palm nuts. The cost of the boiler, including accessories (pressure regulator, manometer, valves, safety valve, gauge glass, flanges) f.o.b. Rotterdam is US$7 000.

Fibre is a good source of fuel as long as air can be passed under the fibre. Technically inexperienced people learned to operate the boiler quickly. Normally the steam valves are fully open and the working pressure amounts to only a few centimetres water pressure. The steam pipes are insulated with coconut fibre, which is held together with wire netting.

J. Nut processing

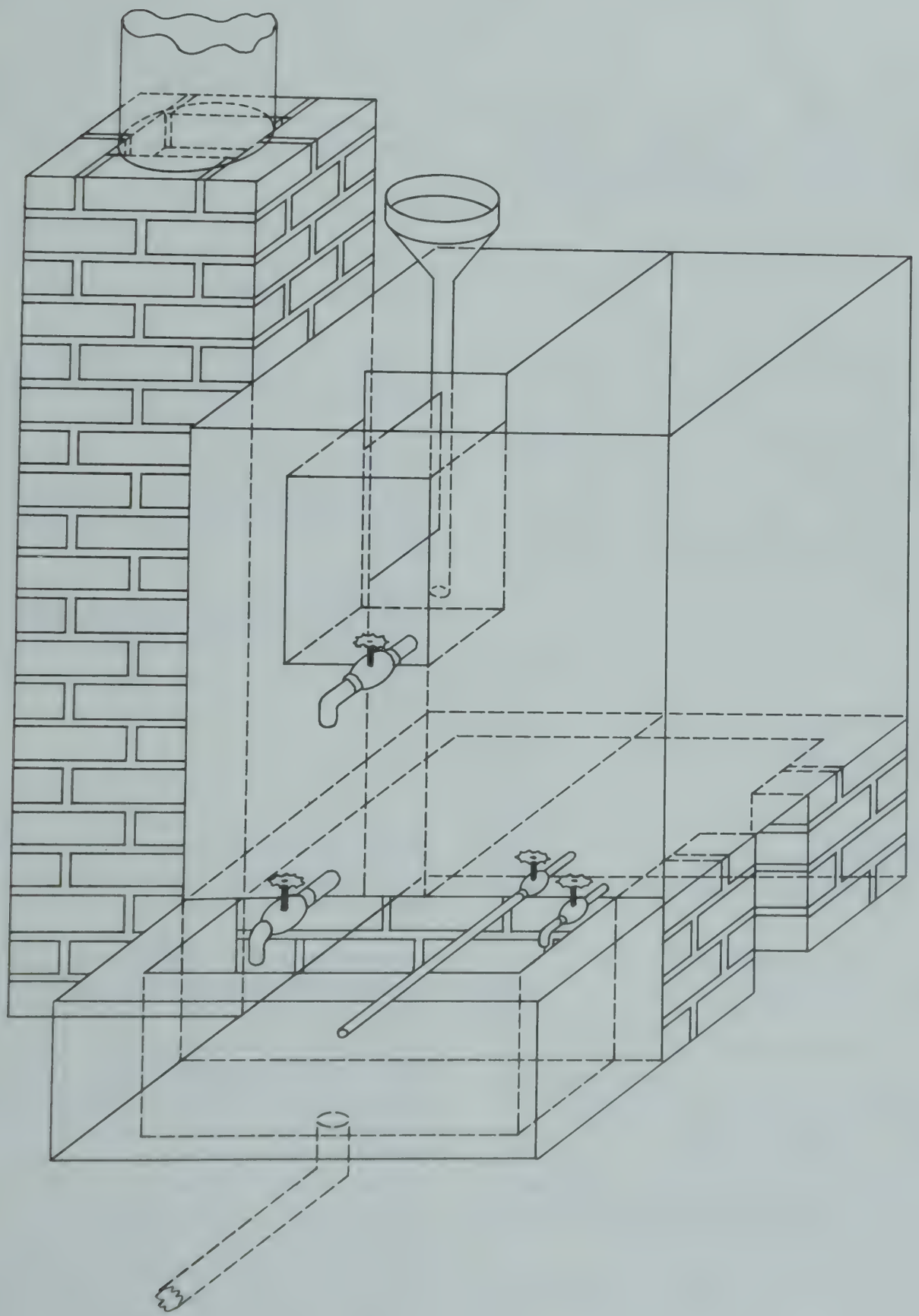
In most of the larger mills about half the processing equipment is devoted to the nut and kernel processing. Such investments are not needed in a village mill. The major labour-saving device will be a nut-cracker, which will replace the pebble normally used to crack every nut individually.

Hand sorting of kernels on a sorting table is an economic operation. The nut processing is outlined in Figure 1.

A nut drier was constructed from local hardwood and consists of two vertical series of seven trays of 180 cm length. The trays are 60 cm wide and 30 cm apart. The space between two series of trays is closed with planks and heated with 2.5 cm diameter pipe. Fresh air enters through openings at the bottom of the drier. The wet nuts are fed via the top of the drier and the dry nuts are removed at the bottom. The holding capacity of the drier is about 2 to The drier occupies a floor space of only 180 cm × 180 cm.

*All equipment is available from ITA, P.O. Box 242, Winschoten, Netherlands

Figure 2 Clarification tank of Mbongo Village palm oil mill



K. Sludge pit oil

A sludge pit of 4 m^3 is in use. Oil recovered from this pit is unsuitable for human consumption because of its high free fatty acid content and its evil smell. A good soap is produced from this oil. The oil is boiled with water before making the soap to remove most of the odour. Any remaining smell can effectively be supressed by the addition of 1% citronella oil to the soap just before casting.

L. Water supply

A hexagonal well was dug and a camwood cage was used as a filter element. The space between the well wall and the cage was filled with gravel. A 6 m^3 Braithwaite tank was placed on a 6 m high camwood frame. A centrifugal water pump, coupled to a 5 hp diesel is used. The water supply is sufficient to serve Mbongo village as well.

Equipment materials & labour used in mill construction

The mill building, storage bins, nut drier, sorting tables and store were all built from local 2.5 cm hardwood. Locally burned bricks were used for the oven and the chimney of the clarification tank. Sterilizer kettles and clarification tank were locally welded. Cement, piping, nails, bolts, locks, hinges, re-enforcing rods and carbolineum wood preservative could be purchased locally.

A. Imported equipment

	Price US $
2 hydraulic Stork hand presses plus tools	17,000
1 centrifugal water pump	400
1 nut cracker of 500 kg/h	1,200
1 digester	3,600
2 diesel engines of 5 hp	5,000
1 Braithwaite tank of 6.9 m^3 (12 plates)	2,200
1 boiler of 120 kg steam/h plus accessories	7,000
Total value of imported equipment f.o.b. Rotterdam in 1979 prices	36,400

B. Quantities of locally obtainable materials (main items only)

15 mild steel plates, 3 mm (1/8"). 1 m × 2 m (3′ × 8′)
2 perforated mild steel plates, 3 mm (1/8"), 1 m × 2 m (3′ × 8′)
40 pieces split iron wood of 480 cm and 12 cm diameter
10 m^3 hardwood including timber for the water tank frame
12 lengths reinforcing rod of 1 cm diameter
230 sheets aluminium of 180 × 90 cm
160 bags cement of which half is used for concrete tiles for the mill floor
5 m^3 gravel and 30 m^3 building sand
80 kg nails of various sizes
12 kg roofing nails
200 burned bricks of 7 m × 11 m × 23 cm for an oven and lower part of a chimney
100 litres green carbolineum wood preservative
40 m pipe of 5 cm diameter
60 m pipe of 2.5 cm diameter
Valves, elbows, coupling sleeves and other bits and pieces.

No prices are indicated as they are variable depending on import duties.

C. Building time

The installation of all equipment including foundations and floor was completed within 4 weeks. It took 150 artisan and 200 labour man–days excluding the production of the mill floor tiles. The author supervised the whole operation.

Mill operation

A. Labour requirements and mill throughput

The labour requirements are based on 1 shift of 8 hours.

	No of persons involved
Filling the sterilizers and feeding the digester	2
Operating of digester and filling of press cages	3
Pressing	3
Emptying press cages	1
Clarification, drum cleaning and drum filling	1
Clerk for mill administration and nut cracker operator	1
Boilerman	1
Total number of persons in oil production	12

It is economic to mechanize pressing as it saves three labourers. However, funds were lacking at construction time to implement this. In some cases it is advisable to employ a nightwatchman.

On normal days the boiler will be started at 5 a.m. and the last sterilizer of fruit cooked the previous day will then be re-heated at 7 a.m. The digester can digest about 400 kg fruit per hour. This implies a capacity of 3.2 tonnes loose fruit (5 tonnes f.f.b.) per 8-hour shift or 800–1,000 kg oil per day plus 150–200 kg kernels per day. Up to 2 tonnes palm oil could be produced, when the mill is operating on two shifts with *tenera* fruit only.

B. Labour costs

A normal basic wage is paid and a high bonus for every drum of oil produced. This bonus is paid to the mill gang as a whole. In Mbongo Mill this bonus amounts to US $5/ 200-litre drum. The bonus is equally divided between all labour and staff. In order to reduce milling costs and to ensure the income of employees, the employees have received half a co-operative farm (one hectare) planted with *tenera* oil palms.

C. Mill fruit purchases

Loose fruit is purchased by volume. This saves the cost of a weighbridge. The bunch stalks are left in the field. The fruit must be free of sand. The Mbongo Mill fruit purchase price during 1979 was US$4/100 litres (half a petrol drum). One hundred litres of *tenera* fruit is equal to 70 kg. The farmer receives a receipt from the tractor driver, that can be cashed at the treasury of the co-operative society.

By-products

A. Soap

About 30 litres of oil are recovered from a 200 litre drum of sludge skimmings from the fat pit. About 40–45 kg soap can be produced from this quantity of waste oil. The soap is sold at competitive prices and is popular.

B. Palm kernel oil

Palm kernel oil was produced on a small scale in 1976 and was used as an additive in soap production to improve the lather quality. Dried kernel is ground twice in a groundnut grinder. Water is heated with the ground kernel in a drum, in amounts up to 5–10% of the weight of the kernel meal. The steaming hot meal is pressed in the hydraulic Stork hand press. Sixteen % oil on meal is removed during the first pressing and another 3% oil can be extracted by removal and immediate reloading of the hot press cake followed by a second pressing. A charge of 20 kg kernel meal will produce 4.2 litres of kernel oil at 70 atmospheres. The palm kernel press cake is fed to the village animals.

Experiences after 3 years operation

The mill operated without major breakdowns according to expectation. There are a few minor adjustments that should be implemented in similar mills. The digester can be overloaded and the installation of a 7–8 hp instead of the present 5 hp diesel engine would solve this problem. Overnight sterilization of the fruit results in a better oil extraction and easier oil clarification.

Crude oil could be transported by gravity to a reservoir adjacent to the clarification tank. The clarification tank performs well but the capacity is too small. The crude oil compartment should be increased to 1,500 litres to allow a longer settling time. A nut-drying floor heated by steam pipes may be simpler to operate than the present nut-drier. A drying floor can also be used for drying other foods. The system of a daily wage plus a bonus for the oil produced was abandoned in favour of a bonus system only. This simplifies the accounting and has improved the team spirit. Mill employment was reduced from twelve to eight or nine. This resulted in an increase in the income of the remaining employees. The present palm oil production per employee per milling day is 100–110 litres. The traditional method of oil production with the same type of fruit is 12–15 litres at the most. The output can be increased to about 150 litres per man-day when the hand press is mechanised.

Many visitors have been received from various African countries and Europe and expressed their enthusiasm on the simplicity, efficiency and productivity of the mill. For that reason the author has given this Village Palm Oil Mill some wider publicity.

Reference

Nwanze, S. C. (1965) The hydraulic handpress. *J. Niger. Inst. Oil Palm Res.*, **4**, (15), 290–316.

QUALITY PROBLEMS ARISING DURING TRANSPORT OF PALM OIL PRODUCTS

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Summary

The transport of palm oil from the oil mill to its ultimate destination is more complex than that of most other oils. Quality may be affected adversely by the equipment and by the handling procedures.

Risks may arise from overheating during melting, excessive aeration during pumping, contamination from other commodities in pipelines and from residues in tanks. The use of standard shipping containers, where appropriate, would avoid most of these risks, and additionally the uncertainty in measuring quantities inherent in the present system.

Résumé

Le transport de l'huile de palme entre la huilerie et sa destination finale est plus complexe que celui de la plupart des autres huiles. La qualité peut en être altérée à cause du matériel et des méthodes de manutention.

Des risques peuvent provenir d'une surchauffe au cours de la fusion, d'une ventilation excessive pendant le pompage, d'une pollution par d'autres produits dans les tuyauteries et résidus dans les réservoirs. Lorsqu'il en est besoin, l'utilisation de conteneurs d'expédition normalisés devrait éviter la plupart de ces risques, sans parler des incertitudes dans la mesure des quantités, qui sont inhérents au système actuel.

Resumen

El transporte de aceite de palma de la almazara a su destino definitivo es más complicado que el de la mayoría de los demás aceites. El equipo y los procedimientos de manipulación pueden influir de manera negativa en la calidad.

Hay riesgo de excesivo calentamiento durante la fusión, así como aireación durante el bombeo, contaminación de otras sustancias en los tubos y residuos de los depósitos. La utilización de recipientes de transporte normales, cuando sea apropiado, evitaría la mayoría de los riesgos y, además, la incertidumbre en la medición de cantidades que son inherentes en el sistema actual.

Introduction

Work on various projects since 1975 relating to palm oil has provided opportunities to collect some first hand information on technical aspects of its transportation. While it is the case that most of the more than 1.25 million tonnes of oil exported from South East Asia reaches its destination in good condition, the present handling system contains some features which may adversely affect the quality of the oil. Any queries about deterioration during transport present a competitive disadvantage in the market place, particularly in comparison to soya bean oil, much of which is extracted and refined close to the time and place of its ultimate use, and therefore not subject to such questions. As the volume of palm oil being exported increases, and new markets are opened up, it may reach installations as yet inexperienced in the necessary precautions.

Transport steps

The various steps in the transport of palm oil may include all of the following:

1. From the oil mill to the sea port by road tanker.

2. Pumping into the shore tank.

3. Pumping into a ship's tank, probably one tank of a parcel tanker.

4. Transport overseas.

5. Pumping into shore installations.

6. Pumping from shore installations into a barge or road tanker.

7. Transport to the oil refinery and pumping into storage tank.

Potential hazards to quality

Problems may start at stage 2. The arriving load is bulked with others in the shore tank, but there are no provisions for efficient mixing. Oil may be aerated during pumping in, leading to oxidation. The oil will partly crystallise in the shore tank. It will be heated and melted before being pumped to the ship, but mixing is inadequate. Therefore,

unless the entire contents of the tank are loaded into a single ship's tank, some differences in composition may arise.

The best practice for loading the ship involves the use of a pipeline reaching the bottom of the tank to avoid aeration. Such pipelines are not always available, and the hot oil may therefore cascade through a 12 m (40 ft) drop, a very efficient way of aerating it and thereby potentiating oxidative deterioration. It is now normal practice to employ surveyors to inspect and certify the condition of the tanks and pipelines employed. The points that have to be watched are numerous.

The ships tanks are normally of mild steel with an epoxy lining. This is quite inert to vegetable oils, provided it is smooth and intact. Damage to the lining causes difficulties in cleaning and may be followed by rusting of the steel and contamination of the oil. Special cleaning routines have to be instituted to remove residues of the previous cargo, if it were of a non - edible nature. Parcel tankers may have a few stainless steel tanks, which could be classified as the ideal material. However these are not usually available for vegetable oils, and their general provision would be prohibitively expensive.

Storage tanks in shore installations are usually of uncoated mild steel, and are normally reserved for vegetable oil use. The risks of damage to the oil are greater than with a protective lining. Such tanks are also rather difficult to clean because the surface is naturally rough.

Many pipeline systems incorporate manifolds which may be used for other commodities, and may then contain residues that are difficult to remove. Pipelines are best emptied by positive 'pigging'. This involves driving a close fitting plug through the pipe by steam or air pressure. Many existing pipelines are not designed so that this can be done. The use of steam to clear pipelines is obviously less effective and introduces water into the oil.

The presence of any copper-containing material in contact with the oil must be guarded against. Because of its relatively high free fatty acid content, palm oil quickly becomes contaminated.

During the sea voyage the oil will partially crystallise, and to a greater extent in the ship's side tanks, because of the greater cooling effect of the sea. The normal practice of heating the oil is to begin heating 4–5 days before reaching the port of discharge, with the objective of reaching a uniform melted condition (at, say, 50–55°C) on arrival. A temperature log is kept by the ship to provide evidence that the correct routine has been used. Heating is normally carried out using steam at 1.5 kg/cm^2 (21.3 lb/in^2) in coils placed at the bottom of the tank. On occasion, higher pressures of 5 kg/cm^2 (71.1 lb/in^2) are reached. These pressures correspond to coil surface temperatures of 127°C and 158° C respectively. A number of shore installations use steam at 7 kg/cm^2 (100 lb/in^2) corresponding to 170°C. These temperatures are high when considered in relation to the chemical reactivity of the palm oil.

If there is a considerable quantity of solid in the tank it will be some time before convection currents become effective, and until this happens there will be local overheating. Furthermore any aqueous impurities in the oil will have settled to the bottom of the tank, and will therefore be available to interact with the oil constituents at high temperature.

These factors may be exacerbated as a result of commercial dealings. It is not usual for a consignment to be bought and sold more than once while it is in transit. The port of destination may be changed, and in consequence oil which has been heated preparatory to delivery will be cooled down and reheated a second time, increasing the opportunities for chemical interaction. Re-heating will also occur when only a part of a ship's tank is required to be unloaded at the first port of call, or when it may be necessary to shift the oil from one tank to another at sea in order to maintain the ship's trim.

Commercial transactions during transit can cause other problems when they involve a change in destination, since they will increase the uncertainty in the time of arrival. Receiving shore installations may then have difficulties in scheduling tank capacity and be forced to mix deliveries or to handle a delivery more than once. Discharge once again involves uncertainties about the cleanliness of pipelines and receiving tanks. In some instances, old fashioned equipment, not specifically designed for vegetable oils, includes copper-containing alloys. Samples may be taken from brass sampling cocks in the delivery pipeline. This carries the dual risks of metallic contamination and of drawing an unrepresentative proportion of any aqueous impurities present.

The proper sampling of bulk say 500 tonnes of oil, which is most probably not uniformly mixed, requires careful consideration. Probably the most satisfactory procedure is to sample at 300 mm (1 ft) intervals throughout the depth of the ship's tank and then bulk and mix the samples. Even then the correct treatment of the bottom sample containing impurities is debatable. Should it be kept separate or mixed in its proper proportion with the bulk? Practice in relation to sampling is not uniform, and it is still possible to see brass sampling instruments being used for palm oil despite the publicity given to their adverse effects (Pike, 1975).

The particular danger of associating brass with the sampling procedure is that subsequent chemical analysis of the sample will indicate a worse quality than actually exists in the bulk delivery. Brass-cased thermometers are also in use for temperature measurements. While the contamination from this source is probably negligible, the principle is wrong.

The foregoing deals with potential hazards to quality and it must be repeated that the great majority of palm oil supplies arrives in good condition. We know from the published work of Johansson (1975) that, when the process is carefully planned and controlled very high quality standards can be attained as a matter of routine.

Courses of action

The present position appears to call for two basic courses of action. Firstly, to provide a sufficient degree of understanding of the technical properties of palm oil for all those responsible for its handling. Palm oil has special characteristics in comparison with other vegetable or animal fats handled in bulk. Secondly, the basic design of equipment for handling palm oil should be thought out from a chemical engineering point of view with those special characteristics in mind.

The use of shipping containers

Is there perhaps a case for an entirely different procedure? Is it worth making a detailed economic study of the use of standard shipping containers for at least a substantial proportion of the supply? There would certainly be very significant technical advantages, some of which can be listed.

1. The container would be filled and sealed at the oil mill. It would not be opened until reaching the refinery.

2. There would be no possibility of external contamination.

3. No deterioration due to overheating or oxygenation during pumping.

4. No problem in off-loading relatively small deliveries.

5. No problem in determining weights and a significant reduction in losses.

6. More flexible system for dealing with special products such as fractionated oil, and partly refined oils.

7. A simple method for serving new customers. Recent marketing studies (Berger, 1977) have predicted the need to find new outlets in countries not yet using palm oil, for the increased supplies expected.

Containers would meet the requirement for small quantities in known condition. Ports without specialised oil storage equipment could be used.

The only technical problem envisaged is some provision for melting the oil out of containers at the receiving end.

References

Pike, M. (1975) Practical aspects of trace metal catalysed oxidation of palm oil, *4th Internat. Symposium on Metal Catalysed Oxidation,* Society of Chemical Industry, London, April 1975.

Johansson, G. (1975) Quality of palm oil, *Chem. Ind.* 902.

Berger, K.G. (1977) Technical requirements for marketing palm oil in the food industry, in: *International developments in palm oil, Proc. of Malaysian Int. Symposium on Palm Oil Processing & Marketing, June 197* (eds. D. A. Earp and W. Newall) pp. 435–454, Kuala Lum Incorporated Society of Planters.

A report by the Marketing and Industrial Economics Department, Tropical Products Institute

World production of palm oil increased to around 3.9 million tonnes in 1978, however, the increase from 1977 to 1978 represented a slowdown in comparison to earlier years in the 1970s. For the period shown in Table 1, 1974–78, growth in production was on average over 9% per annum, in comparison to below 4% for 1977 to 1978. Nevertheless, production in 1979 is expected to expand more rapidly and in the longer term, palm oil is projected by the FAO to show the fastest growth in the oils and fats sector, with total production estimated at over six million tonnes in 1985.

The majority of the present increase in production continues to be centred in Malaysia (Peninsular Malaysia and Sabah), where production reached 1.7 million tonnes in 1978. This expansion was inhibited by the effects of the drought which extended from 1977 into the first half of 1978. However, production recovered sharply in the latter half of the year, continuing into 1979, with January production 55% up on a year earlier.

Amongst the other palm oil producing countries, Indonesian output grew more slowly in 1978 than in

Table 1
World production of palm kernels and palm oil

'000 tonnes

	1974		1975		1976		1977		1978	
	Oil equivalent*	Kernels	Oil equivalent*	Kernels	Oil equivalent*	Kernels	Oil equivalent*	Kernels	Oil equivalent*	Kernels
Palm kernels										
Benin	39	82	34	73	38	80	38	80	38	80
Cameroon	19	40	21	45	21	45	22	47	23	49
Ghana	16	33	16	34	15	32	14	30	15	32
Ivory Coast	18	39	17	36	17	36	15	32	18	38
Nigeria	146	310	139	295	165	350	176	375	176	375
Sierra Leone	21	45	24	52	21	44	22	46	24	50
Zaire	36	77	35	75	35	74	34	72	34	72
Mexico	6	12	7	15	14	30	14	30	14	30
Brazil	113	240	113	240	127	270	108	230	108	230
Colombia	10	22	8	17	7	14	8	17	8	18
China, People's Rep. of	17	36	18	38	19	40	20	42	21	44
Indonesia	35	74	39	82	39	82	43	92	47	100
Peninsular Malaysia	92	195	110	233	116	246	143	305	147	312
Sabah	9	20	9	20	11	24	8	16	8	16
Other	54	115	50	106	52	111	53	112	56	119
World total	630	1,340	640	1,361	697	1,478	718	1,526	737	1,565
Palm oil										
Angola	40		40		40		42		40	
Benin	26		22		30		25		35	
Cameroon	60		60		80		82		84	
Guinea	37		40		35		38		41	
Ivory Coast	146		153		151		148		135	
Nigeria	485		640		655		660		680	
Sierra Leone	45		55		44		46		50	
Zaire	174		165		178		175		175	
Colombia	55		39		40		49		55	
China, People's Rep. of	145		150		160		162		163	
Indonesia	334		397		434		497		505	
Peninsular Malaysia	942		1,135		1,261		1,484		1,555	
Sabah	88		123		124		117		137	
Papua New Guinea	16		23		32		32		32	
Other	137		221		179		206		214	
World total	2,730		3,263		3,443		3,763		3,901	

Note: * Converted at 47% oil content

Sources: FAO Production Yearbook
FAO Monthly Bulletin of Agricultural Economics and Statistics

Table 2
Exports of palm kernels and oil and palm oil

'000 tonnes

	1974		1975		1976		1977		1978	
	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil
Palm kernels and oil										
Benin	10	–	–	3	–	16	–	14	–	3
Cameroon	26	–	12	–	12	–	10	–	10	–
Ivory Coast	39	–	36	–	36	–	17	–	4	14
Nigeria	186	38	173	21	272	13	200	20	120	39
Sierra Leone	25	9	29	10	22	10	5	10	3	8
Zaire	–	34	–	29	–	23	–	15	–	17
Indonesia	29	12	32	14	31	21	26	17	10	10
Peninsular Malaysia	–	92	–	109	–	124	2	105	1	130
Sabah†	20	–	24	–	24	–	–	–	–	21
Other	55	120	16	35	17	33	34	39	n.a.	n.a.
Word total	390	305	322	221	414	240	294	220	n.a.	n.a.
Total in oil equivalent*		488		372		435		358		n.a.
of which kernels in oil equivalent*		183		151		195		138		n.a.
Palm oil										
Benin		2		6		10		4		–
Cameroon		18		9		6		9		7
Ivory Coast		102		114		92		78		68
Zaire		69		53		40		22		10
Indonesia		281		386		406		405		400
Peninsular Malaysia		813		1,032		1,130		1,262		1,310
Sabah†		88		125		126		124		144
Papua New Guinea		9		18		28		25		30
Other		302		232		254		215		n.a.
World total		1,684		1,975		2,092		2,144		n.a.

Sources: FAO Trade Yearbook
FAO Monthly Bulletin of Agricultural Economics and Statistics
Oil World

Notes: * converted at 47% oil content
† figures from 1977 include Sarawak
‡ preliminary
n.a. not available

previous years. Amongst West African producing countries, Nigerian production has continued to remain relatively stagnant and in other cases, for example Sierra Leone, a declining trend is apparent.

Exports of palm oil (Table 2) continued to show an upward trend in 1978, although such expansion was relatively modest. The bulk of this growth was again accounted for by Malaysia, where the supply situation eased during the latter half of the year as a result of the recovery in production. Amongst other exporters, supplies from Indonesia have stagnated as a result of increasing pressure of domestic consumer demand and limited growth in production during the past year. Papua New Guinea has become established as a new supplier, but West African suppliers registered a continuation of the sharp decline in exports which has been apparent since the mid 1970s.

As a result of these trends in exports, Malaysia has continued to build upon its predominant position in global exports of palm oil. Malaysia has also continued to supply an increasing proportion of palm oil exports in processed form. In 1978 less than 40% of Malaysian exports were in crude form and this percentage may be expected to fall further with the continued expansion of domestic processing capacity.

For imports of palm oil (Table 3), particular interest is focussed upon the changing patterns of consumption between importing countries. Imports into the EEC countries fell in both 1977 and 1978, with much of the fall in 1978 registered during the last quarter. Of significance in this respect has been the variable levels of competitiveness of palm oil with soyabean oil, with palm oil even commanding a premium at times. Imports into Japan have also fallen and the United States of America has continued to register particularly heavy reductions. An overriding factor in the United States of America has been the reversal of relative prices between palm and soyabean oil since 1976, with palm oil commanding a premium.

Imports of palm kernels and oil and palm oil

'000 tonnes

	1974		1975		1976		1977		1978†	
	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil
Palm kernels and oil										
France	17	18	12	22	9	15	12	16	8	15
Germany, Fed. Rep. of	58	34	42	17	50	21	73	13	15	17
Netherlands	149	24	98	41	137	35	85	45	54	59
United Kingdom	49	57	75	64	88	65	56	61	43	64
United States of America	–	70	–	72	–	68	–	67	–	60
Other	96	51	67	38	77	45	73	39	n.a.	n.a.
World total	369	254	294	254	361	249	299	241	n.a.	n.a.
Total in oil equivalent*	427		392		419		382		n.a.	
of which kernels in oil equivalent*	173		138		170		141		n.a.	
Palm oil										
France	56		50		65		67		67	
Germany, Fed. Rep. of	133		210		193		198		170	
Italy	54		51		59		33		58	
Netherlands	147		186		191		183		151	
United Kingdom	219		206		242		229		220	
Canada	16		41		55		31		23	
India	53		18		21		300		n.a.	
Pakistan	30		151		120		141		n.a.	
Iraq	73		124		35		100		n.a.	
Japan	115		108		154		147		142	
United States of America	200		442		361		251		146	
Other	461		278		376		393		n.a.	
World total	1,557		1,865		1,872		2,073		n.a.	

Sources: FAO Trade Year Book
FAO Monthly Bulletin of Agricultural Economics and Statistics
Oil World

Notes: * converted at 47% oil content
† preliminary
n.a. not available

These reversals however, have been more than compensated by the rapid build up of imports to India, amounting to 300,000 tonnes in 1977 and estimated at almost 400,000 tonnes for 1978. Traditionally, Indian consumers have shown a preference for groundnut oil, but relatively limited domestic production of fats and oils as a whole has led to the dramatic expansion of imports in recent years, notably of relatively cheaper soyabean, palm and rapeseeed oils. Most recently, (1979), the prospects for imported fats and oils have become less certain in the context of some recovery in domestic oils and fats production and the imposition of import duties, as such palm oil imports for 1979 are expected to be below levels reached during the previous year. Other countries which have recently emerged as significant importers include Pakistan and also Kenya (not listed on Table 3).

The overall change in the pattern of importing countries may be expected to continue in future. The EEC and the United States of America, although remaining as important markets, are likely to account for a diminishing share of global palm oil imports. If the forecast expansion of palm oil production is to be absorbed, consumption growth will have to occur elsewhere, notably in Asia, but also perhaps in Africa and even China. An element clearly of great importance will be the extent to which India continues to absorb a substantial fraction of traded palm oil.

Palm kernel production has continued to expand at a moderate rate, such that by 1978 the global total approached 1.6 million tonnes. Malaysia and Indonesia have both contributed to the increases which have occurred, but in other major producing countries - Brazil and Nigeria - production has stagnated. Although Malaysian palm oil production has outstripped that of Nigeria very considerably, palm kernel production is still below the Nigerian level because of the small kernel in Malaysian hybrid palms.

The recovery in the level of exports, both of kernels and palm kernel oil in 1976 was not maintained in 1977 and indications are that for 1978 a further sharp fall in kernel exports occurred, although palm kernel oils recovered to some extent. Contraction in kernel exports has largely been due to sharply reduced shipments from Nigeria but other exporting countries have also shown declines. In part the recovery in palm kernel oil exports in

Table 4
Prices of palm kernels and oil and palm oil: quarterly and annual averages

US $ per tonne

		Palm kernels	Palm kernel oil		Palm oil	
		Nigerian dealer c.i.f. Europe	Malaysian c.i.f. UK	West African c.i.f. UK	Malaysian 5% f.f.a. c.i.f. continent	Malaysian/Sumatran (resale) c.i.f. continent
1974	I	601	–	1,438	643	771
	II	503	1,036	1,144	578	636
	III	442	1,008	964	685	677
	IV	381	732	788	767	746
	Annual	482	926	1,083	699	710
1975	I	249	492	518	489	450
	II	184	502	371	371	385
	III	191	495	–	509	420
	IV	200	479	422	427	421
	Annual	207	492	438	449	416
1976	I	158	–	329	363	387
	II	201	–	–	362	372
	III	260	–	–	451	446
	IV	291	523	–	455	456
	Annual	228	523	329	404	415
1977	I	333	610	553	521	524
	II	405	769	–	652	643
	III	279	448	–	–	506
	IV	273	507	–	438	498
	Annual	323	637	553	551	543
1978	I	320	608	–	–	561
	II	357	654	–	583	647
	III	366	700	–	–	640
	IV	421	835	–	–	631
	Annual	366	699	–	583	620

Source: *The Public Ledger*

1978 stems from a shift towards exports of oil rather than kernels amongst West African exporters, but of particular importance was the contribution of exports from Malaysia.

On the import side, sharp if erratic reductions were registered for palm kernels in both 1977 and 1978 for the major European importers, the most consistent declines occurring in the UK and the Netherlands. In contrast palm kernel oil imports have remained fairly consistent in recent years with both EEC countries and the United States of America as the major consumers.

Palm oil prices (Table 4) in 1978 were affected both by the continuing influence of the 1977 drought and also by demand factors. In the first half of the year, the strong market performance by the oils and fats sector generally, coupled with a tight supply situation in palm oil in particular, produced a recovery of prices to levels equivalent to 1977 peaks. As expected however, prices fell away slightly towards the end of the year as the supply situation eased.

During the first quarter of 1979 palm oil prices again turned upwards partly in response to general commodity market uncertainty stemming from developments in Iran and also those in China and Vietnam. Although prices could remain steady as a result the upward trend in petroleum oil prices and hence raised transportation costs, the general expectancy in the fats and oils markets is for a downturn in prices. This expectation is based upon the probability of a reduction in net import requirements for India and possibly China, and increased export availability in Latin America. Some further uncertainty exists however, on the extent to which the Soviet Union and China will enter the market.

Palm kernel and palm kernel oil prices have continued to maintain a strong recovery which commenced during the last quarter of 1977. This has occurred in the context of only modest overall expansion of production and also a tight supply situation for copra. As such, price movements for palm kernel oil have registered much sharper changes than those for palm oil. (See Table 4).

THE OIL PALM. C.W.S .Hartley. Longman Group Ltd., London, 2nd Edition, 1977: pp.xviii + 806, 83 hàlf-tone plates, 19 colour plates, 102 line drawings, price (UK only) £25.00. ISBN O 582 46809 4

Ten years have passed since the publication of the first edition and although a revised impression was issued in 1970, this has now been out of print for some years and the long awaited new edition, of what has become a standard textbook for the oil palm industry, will be widely welcomed.

The chapters have been revised and generally brought up-to-date and in many cases have also been enlarged.

Chapter 1, on the origin and development of the oil palm industry, has been expanded somewhat to include a discussion of the various methods by which the oil palm industry has developed during the last decade, including settlement schemes, nucleus estates with peripheral small-holdings and also pure estates.

Increasing interest in the American oil palm, the botanical name now correctly given as *Elaeis oleifera* (HBK) Cortés, and its hybrids with the African oil palm, is reflected in increased attention given to these in several chapters. Thus chapter 2, on the botany of the oil palm, now includes more details of the characteristics of both the American species and the hybrids, while chapter 5, on selection and breeding, provides considerable additional information on the employment of *E. oleifera* in breeding. Chapter 13, on diseases and pests, includes an account of the commercial planting of hybrids at La Arenosa in Colombia where they have shown resistance to Lethal Bud Rot disease which has devastated *E. guineensis* plantations in the area. Chapter 14, on the products of the oil palm and their extraction, now combines more up-to-date and detailed fatty acid compositions of the mesocarp and kernel oils of both *E. oleifera* and hybrids from Colombia, Africa and Malaysia.

The revision of chapter 3 (The oil palm and its environment) and chapter 4 (Factors affecting growth, flowering and yield) take account of progress made in relating climate and soil to yield and of work on growth analysis. The decreased importance of African palm groves in the total supply of palm products is reflected in a reduction in the section of chapter 3 which deals with this topic.

The contents of chapters 6–10 on the preparation, storage and germination of seeds (chapter 6), the raising of nursery seedlings (chapter 7), the preparation of land (chapter 8), the establishment of palms in the field (chapter 9) and the care and maintenance of a plantation (chapter 10) have all been revised to take account of the progress made in cultural practices; with chapter 8 including a new section on irrigation.

Chapter 11, on nutrition, has been rewritten and rearranged to allow for a substantial body of new data on many aspects of the nutrition of the palm. Chapter 12, on mixed cropping, rearing livestock among oil palms and tapping for wine has been slightly enlarged and chapter 13 (diseases and pests) has been up-dated and expanded, and now contains in addition, a section on monitoring disease and pest incidence. Chapter 14 now includes sections on fractionation and effluent disposal, both of which are of particular interest to Malaysia where the latter is a pressing and, as yet, only partially solved problem.

This new edition is well produced with a new type-face and binding and the half-tone plates have now been incorporated into the relevant pages of the text which makes for easier reference. Most of the measurements have been converted to metric units but a few figures from the previous edition have escaped. Although there is a conversion table of common weights and measures at the end of chapter 10, this would doubtless be easier to find if placed at the end of the book.

Very few misprints have been noted, but a reference on page 699 to 'fully unsaturated triglycerides of high melting point' is an obvious error which has been continued from the previous edition. The reference number for the table on page 752 in incorrect and should be 73. There is a good number of 1975 and 1976 references. It almost goes without saying that those who have become familiar with the first edition will wish to possess this up-dated and enlarged version. As a standard textbook on the oil palm, it is strongly recommended to all who are concerned with this crop.

J.A.C.

General

EFFECT OF FERTILIZERS ON THE COMPOSITION OF THE LIPIDS PRODUCED BY PERENNIAL TROPICAL OIL PALMS AND ON THEIR YIELDS

(Effet des engrais sur la composition des lipides produits par des oléagineux tropicaux pérennes et sur leur rendement)

Ochs, R. and Ollagnier, M. (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1977, **32** (10), 409–426.

(In French and English. Spanish summary, 23 lines)

Experimental results from agricultural research are used in this survey to clarify the part which fertilizers play, or could play, in the production of lipids in the tropics. The fertilizer response is examined both for oil palm and coconut for response to individual nutrients and to the rates applied.

It is found that the potassic fertilizers play the foremost role in the fertilization of these crops, followed by nitrate, phosphate and magnesium fertilizers. The choice of salts used has also assumed great importance.

The few results available from experimental data do not permit the formulation of any general hypothesis concerning the effects of fertilizers on quality. However, in the majority of cases, fertilizer greatly increases the yield of primary products without noticeable effect on their oil content or on the quality of the oil, which is so controlled by genetics as to be almost insensitive to enviromental conditions.

THE TRAINING OF OPERATORS OF AGRICULTURAL TRACTORS ON ESTATES IN MALAYSIA–A REVIEW

Anderson, J. (Nova Scotia Estate, Teluk Anson, Perak, Malaysia), *Planter, Kuala Lumpur,* 1978, **55** (623), 84–93.

The author maintains that some form of training rather than demonstrations is essential in view of the special difficulties encountered in estate tractor operations. The relationship between supplier, management and driver is discussed and illustrated by an account of what can happen when the correct relationship does not exsist.

THE MAINTENANCE OF ESTATE VEHICLES AND STATIONARY ENGINES

Hartley, C. D. H. (Air Putih Estate, Kota Tinggi, Johore, Malaysia) *Planter, Kuala Lumpur*, 1978, **54**, 12–40.

Workshop organisation and maintenance procedure is discussed in the context of the particular needs of estates. Specimen maintenance schedules are given and explained as a guide to management.

MAINTENANCE OF STATIONARY ENGINES

Bentley, M. P. (Harrisons Lister Engineering Co. Ltd., Kuala Lumpur, Malaysia) *Planter, Kuala Lumpur,* 1977, **53** 395 –408.

The paper covers fundamental aspects of maintenance of small and medium - sized stationary diesel engines, as being representative of those in use on rubber, palm oil and other estates in Malaysia. The importance of preventive maintenance is stressed, together with the advantages that can accrue. The need for satisfactory standards for estate technical staff, particularly those directly concerned, e.g. fitters, engine drivers and attendants, is noted and the subject of training facilities, trade testing etc., is generally covered.

TECHNICAL LIMITATIONS TO THE DEVELOPMENT OF PERENNIAL OIL PLANTS (OIL PALM AND COCONUT) IN WEST AND CENTRAL AFRICA– SITUATION OF RESEARCH ON THE TECHNIQUES OF PLANTATION ESTABLISHMENT AND MAINTENANCE.

(Les constraints techniques du développement des oléagineux pérennes (palmier et cocotier) en Afrique occidentale et centrale. État des recherches sur les techniques de création et d'entretien)

Ochs, R. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1977, **32** (11), 469–477.

(In French and English. Spanish summary, 14 lines)

To make the best use of the ever more productive planting material of perennial oil plants, such as oil palm and coconut, being made available to planters, one must adopt intensive agricultural systems which are possible only by the application of a certain number of techniques which have been worked out progressively in the face of the various constraints encountered in the extension of these

crops. The original solutions described here concern land preparation or replanting according to whether oil palm or coconut is in question, nurseries, maintenance methods, growing techniques in drought zones, fertilization and crop protection. The problem of interplanted crops is also dealt with, as well as the need for supervision and technical assistance.

INDONESIA PALM EXPANSION PLANNED

Anon., *The Cocomunity*, 1978, 8 (6), 7.

Indonesia plans to raise its palm oil output to 518,000 tonnes in 1978. The expansion will be based on a larger growing area, including switching from former rubber land. About 90% of Indonesia's palm oil is currently produced by state-owned plantations centred in Sumatra; nearly all of which have factories and laboratories.

THE DIVERGENCE ANGLE OF OIL PALM LEAVES: MEASUREMENT AND POSSIBLE CONSEQUENCES

(Angle de divergence des feuilles du palmier à huile: mesure et conséquences possibles)

Hirsch, P. J. (IRHO Station, La Mé, Ivory Coast), *Oléagineux*, 1978, **33** (3), 109–112.

(In French and English. Spanish summary, 12 lines)

The divergence angle of oil palm leaves has been measured with a compass without causing damage to the tree. Measurements taken on 512 palms have shown differences between lines but not between land use antecedents. The construction of models show that palms with a wider angle capture more energy, leading to greater photosynthesis and transpiration; consequently they are favoured in a moist climate whereas a smaller angle is preferable in a dry climate. Correlation between angle and yield in two moist years and one dry in the Ivory Coast confirm this model.

ROAD IMPROVEMENT WORK IN INDUSTRIAL OIL PALM PLANTATIONS – STABILISATION OF ROADWAYS WITH CONCRETIONARY LATERITE FILLING

(Les aménagements routiers en palmeraies industrielles - Stabilisation des chaussées par épandage de latérite gravillonnaire)

Huguenot, R. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1976, **31** (11), 475–478.

(In French, English and Spanish)

Road improvement is described in terms of material used, preparation and grading of road, surfacing and maintenance of the surface. The paper completes IRHO advice note 91 which dealt with the metalling of the kilometric roads and the heavy duty tracks in plantations being laid out. (IRHO advice note 166).

OIL MILL ENERGY SOURCES AND POWER BALANCES IN A PALM OIL OPERATION

(Sources d'énergie et bilan énergétique dans une huilerie de palme)

Fonade, B. E. (Speichim, 104 Rue Edouard Vaillant. 93140 Bondy - B P 12, France), *Oléagineux*, 1977, **32** (7), 333–337.

(In French. English and Spanish summaries, 3 and 5 lines)

The article discusses the equipment needs for the use of waste materials in supplying steam and electricity in palm oil mills. Energy balance is considered for mills of varying capacity.

Breeding

EFFECTS OF X–IRRADIATION ON OIL PALM (*Elaeis guineensis* JACQ.) SEEDLINGS

Tan Geok-Yong (Department of Plant Science, University of Alberta, Edmonton, Alberta, TG6 2E1, Canada) and Rajaratnam, J. A. (Chemara Research Station, Seremban, Malaysia), *Planter, Kuala Lumpur*, 1977, **53**, 192–196.

Germinated seeds of oil palm were irradiated with X-rays at dosages of 500, 1,000, 2,000 and 4,000 rad. The effects of such irradiation on growth and morphological characters were investigated at seedling stages. Exposure to 4,000 rad was found to be lethal to the germinated seeds. A high frequency of malformation including 'grass leaf', 'little leaf' and 'twisted leaf' was demonstrated on the four month old seedlings at different dosages. More than 25% of the surviving seedlings, which received dosages of 2,000 rad, were found to develop two shoots each. Seedlings with three or four shoots were also observed . The growth of the treated seedlings was greatly inhibited. Prospects of utilising induced mutation techniques in oil palm improvement are discussed.

CHARACTERISTICS OF A GERMINATOR AND OUTBUILDINGS

(Caractéristiques d'un germoir et des bâtiments annexes)

Guichard, P.–H. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1977, **32** (10), 427–431.

(In French, English and Spanish)

The construction of a germinator building is described with diagrams for two types of heating installation, namely the standard isothermal germinator working on a hot water system from a central heating type boiler and an electric germinator using hot air produced by a fan heater. The standard isothermal generator described has a capacity for about 500,000 seeds. (This advice note, numbered 176, replaces IRHO advice notes 122 and 134).

MEASUREMENT OF MITOCHONDRIAL ACTIVITY IN THE OIL PALM *(E.guineensis* JACQ.) - DEMONSTRATION OF MITOCHONDRIAL HETEROSIS, AND COMPARISON OF THE MITOCHONDRIAL ACTIVITY OF SEVERAL HYBRIDS
(Mesure des activités mitochondriales chez le palmier à huile *(Elaesis guineensis* Jacq.)–Mise en évidence de l'hétérosis mitochondrial, et comparasion des activités mitochondriales de plusieurs hybrides)

Kouame, B. (IRHO Station, La Mé, Ivory Coast), *Oléagineux,* 1978, **33** (6), 267–275.

(In French and English. Spanish summary, 12 lines)

An approach to heterosis through studying the oxidative and phosphorylant activities of mitochondria has been tried on several oil palm hybrids and their parental lines. The mitochondrial parameters were studied through a polarographic technique for measuring oxygen. The hybrids studied generally had a biochemical performance superior to that of their parental lines. In an effort to find a workable test for selecting oil palm, comparisons were made between the mitochondrial activities of eight hybrids and their productivity. Good correlations were found to exist between the three parameters characterising mitochondrial activities (ADP/O, RC and QO_2) of the hybrids and their productivity.

Agronomy

OIL PALM – CHOICE OF PLANTS IN THE NURSERY
(Palmier à huile. Choix de plants de pépinière)

Wuidart, W. and Boutin, D. (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1976, **31** (8–9), 371–374.

(In French , English and Spanish)

The authors maintain that the general use of plastic bags in oil palm nurseries means that new criteria must be adopted for the culling of abnormal plants. Criteria for normal plants in terms of height, girth and number of functional leaves after about eight months in the nursery are given, together with types of abnormal seedlings to be culled and the method of culling. (This IRHO advice note 164 completes IRHO advice note No. 28, *(Oléagineux,* 1964, No. 4) which concerned field nurseries).

LEAF ANALYSIS FOR THE CONTROL OF NUTRITION IN OIL PALM PLANTATIONS – TAKING LEAF SAMPLES
(Le diagnostic foliaire pour le contrôle de la nutrition des plantations de palmiers à huile – prélèvement des échantillions foliaires)

Ochs, R. and Olivin, J. (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1977, **32** (5), 211–216.

(In French, English and Spanish)

The authors emphasise the importance of taking leaf samples for analysis according to very strict rules. These are described with regard to whether the samples are to be analysed for systematic control of nutrition in a plantation or for the study of particular aspects; confirmation of common deficiency symptoms or research into the causes of development anomalies etc. The authors discuss the composition of samples with regard to the choice of leaf to be sampled and the choice of sampling period and the number of trees involved in the composition of the sample. Samples for periodic controls are considered with regard to density of sampling and the choice of trees to make up the samples and the special or directed samples with regard to early control of the mineral nutrition, confirmation of periodical samples, the cases of magnesium and boron deficiencies and the study of anomalies.

The conditioning of samples to ensure their conservation and preparation with a view to laboratory analysis is described in IRHO advice note 170 *(Oléagineux,* 1977, **32** (3), 95–99). (This IRHO advice note is 172).

YIELD RESPONSE OF OIL PALM TO FERTILIZERS IN WEST MALAYSIA – II, INFLUENCE OF SOIL AND CLIMATIC FACTORS

Foster, H. L. and Goh Hock Swee, *MARDI Res. Bull.,* 1977, **5** (1), 6–22.

In a selection of oil palm fertilizer trials carried out in West Malaysia, f.f.b. yield responses to N, P and K fertilizers at optimal levels of other fertilizers and after adjustment for yield level and palm factors, have been examined in relation to soil and climatic factors. In the trials on coastal soils, average N and P responses were positively related to annual rainfall. In the trials on inland soils, N and K responses in individual years were negatively related to both intensity of leaching after fertilizer applications and frequency of fertilizer applications, whilst K responses averaged over several years were positively related to soil pH and negatively related to soil clay content. On inland soils, average P responses were also positively related to soil pH.

YIELD RESPONSE OF OIL PALM TO FERTILIZERS IN WEST MALAYSIA – III, LEAF NUTRIENT LEVELS

Foster, H. L. and Chang Kwong Choong, *MARDI Res. Bull.,* 1977, **5** (2), 56–73.

Response functions have been satisfactorily fitted to leaf 17 nutrient data collected from different oil palm fertilizer trials carried out in West Malaysia. These showed that as well as increasing the level of the individual nutrients which they supply, fertilizers also significantly affect the levels of other leaf nutrients. In particular, fertilizer N generally increases leaf P and K but decreases leaf Ca and Mg, fertilizer P generally increases leaf N but decreases leaf K, fertilizer K generally increases leaf N but decreases leaf Ca and Mg, whilst fertilizer Mg sometimes increases leaf P and generally decreases leaf K.

The relationships between yield and leaf nutrient levels predicted by the response functions have been examined in selected trials, and it is concluded that in a particular environment, maximum yield can be obtained at only one

specific combination of leaf nutrient levels, but a moderate yield can be obtained over a wide range of leaf nutrient levels.

In practice it is first necessary to determine the leaf levels which correspond to the maximum yields in a particular enviroment and then deduce the levels which correspond to the most economic yield. When the economic yield is not much below the maximum yield, the level of leaf N and P and the combined level of leaf (K + Mg) will not be appreciably different from the leaf levels corresponding to maximum yields; but when economic yield is appreciably below the maximum yield, any of the leaf nutrients can vary appreciably from the levels which correspond to maximum yield.

SEASONAL FLUCTUATIONS IN OIL PALM NUTRIENT LEVELS

Foster, H.L. and Chang Kwong Choong, *MARDI Res. Bull.*, 1977, **5** (2), 74–90.

Seasonal fluctations and a concentration of nutrients in leaf 17 of oil palms were examined in relation to changes in rainfall, soil moisture, yield level and time of fertilizer application, in nineteen oil palm fertilizer trials carried out in West Malaysia. On coastal soils, leaf P and K were found to increase with the average level of soil moisture prior to sampling, whilst on inland soils, leaf K and Ca were found to decrease with the average rainfall received prior to sampling and leaf Mg decreased with the yield level prior to sampling. Equations are presented which can be used to correct for these leaf nutrient fluctuations.

ECOLOGICAL LIMITATIONS TO THE DEVELOPMENT OF PERENNIAL OIL PLANTS (OIL PALM AND COCONUT) IN WEST AND CENTRAL AFRICA – CHOICE OF THE PLANT AS FUNCTION OF CLIMATE AND SOIL

(Les constraintes écologiques du développement des oléagineux pérennes (palmier er cocotier) en Afrique occidentale et centrale – choix de la plante en fonction du climat et du sol)

Ochs, R. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1977, **32** (11), 461–468.

(In French and English. Spanish summary, 10 lines)

Knowledge of the climate and soil requirements of the oil palm and coconut enables the zones devoted to the growing of these two crops to be divided up to the best advantage. The suitable areas are considerable, and it appears that the coconut growing can be greatly developed inland. The results of performance trials inland in the Ivory Coast and in a dry zone in Benin prove the hardiness of the hybrid coconut and thus offer new prospects for this crop.

STUDY OF A SULPHUR DEFICIENCY ON YOUNG OIL PALMS IN THE IVORY COAST

(Étude d'une déficience en soufre sur jeunes palmiers à huile en Cote-d'Ivôire)

Calvez, C. (Robert-Michaux Plantation, Dabou, Ivory Coast), Olivin, J. (IRHO, 11 Square Pétrarque, Paris 16e, France) and Renard, J. L. (IRHO, Robert-Michaux Plantation, Dabou, Ivory Coast), *Oléagineux*, 1976, **31** (6), 251–257.

(In French and English. Spanish summary, 38 lines)

An experiment was set up in October 1972 in the Dabou savannah to confirm the effect of sulphur on young palms planted on heavily desaturated soils in which a sulphur deficiency had already been noted. Sulphur was provided in the form of ammonium sulphate. The other treatments were one receiving nitrogen in the form of urea and a non-fertilized control. The first leaf analysis made at sixteen months (February 1974) showed a nitrogen deficiency corrected by urea and ammonium sulphate and a sulphur deficiency corrected by the sulphate only. The application of nitrogen in the form of urea and without the accompanying sulphur application led to an aggravation of the sulphur deficiency and a nutritional disturbance bringing about a fall in the levels of all the other elements. The improvement of the sulphur nutrition, thanks to ammonium sulphate, took shape in the form of better growth of the young palms. On the contrary, the palms receiving urea were no better developed than the controls, as the positive effect of nitrogen on growth was counterbalanced by the depressive effect of the sulphur deficiency. At the age of 27 months (January 1975), leaf analysis showed almost total natural correction of the nitrogen and sulphur deficiencies in the control palms. However, urea again raised the nitrogen levels while ammonium sulphate still improved the nitrogen and sulphur levels. The palms receiving sulphate were still the best developed. The reduction of damage to the foliage by *Cercospora* leaf spot is a secondary effect of good sulphur nutrition. The sulphur levels in the well-nourished trees are at least equal to 0.200% on dry weight. Examples of sulphur deficiency in oil palms are fairly rare, but care must nevertheless be taken from the early years onwards to ensure correct nutrition and adequate fertilization in this element, as it was possible to show in an older experiment that under-developed palms produced less during the first two or three harvesting years.

REPLANTING OF INDUSTRIAL OIL PALM PLANTATIONS. LAND PREPARATION

(Replantation des plantations industrielles de palmiers à huile. Préparation du terrain)

Huguenot, R. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1977, **32** (6), 261–266.

(In French, English and Spanish)

Replanting becomes necessary after about 25 years of exploitation when yields begin to decrease and the trees become too tall for harvesting without climbing. The need for meticulous land preparation according to an exact timetable is stressed so that weeds may be eliminated and legume cover sown at the appropriate time. Before felling

the old trees, the soil is cleaned to get rid of weeds, including uprooting by hand all shrubs and bushes followed by windrowing and ploughing. The palms are then felled and windrowed and finally the cover is sown just before the rainy season. The method described can be used on most plantations except where there are phytosanitary problems and average working times for the preparation is tabulated. (IRHO advice note 173).

AN OIL PALM FERTILIZER EXPERIMENT ON VOLCANIC SOILS IN PAPUA NEW GUINEA

Breure, C. J. (Dami Oil Palm Research Station, Kimbe, West New Britain, Papua New Guinea) and Rosenquist, E. A. (Harrisons Fleming Advisory Services, 1–4 Great Tower Street, London, EC3R 5AB, England), *Oléagineux,* 1977, **32** (7), 301–310.

(In English and French. Spanish summary, 25 lines)

Data are presented for a fertilizer experiment started in 1969 on young oil palms growing on newly cleared volcanic ash soils in Papua New Guinea. The design is a quarter replicate of a $4^2 \times 2^4$ testing nitrogen and potash at four levels in the presence or absence of magnesium, manganese, sulphur and phosphate. The records presented include the effects of the treatments on yield, growth, major and minor nutrient levels in fronds 3 and 17 and soil analysis data. Nitrogen and phosphate have had little effect on growth and yield. Muriate of potash has increased yield but decreased frond potash levels whilst increasing the levels of calcium and chlorine. The yield increase is probably due to the chlorine in muriate of potash. Magnesium, manganese and sulphur have improved growth but have so far not increased yield. Urea has reduced soil pH and exchangeable magnesium. Sulphur has reduced soil pH, the cationic exchange capacity, organic carbon and exchangeable calcium, magnesium and potash in the soil. Nutritional problems are associated with anions, the high pH of the soil, its weak buffering capacity and its high exchangeable calcium content.

PRACTICAL ADVICE ON FERTILIZING OIL PALMS – SIMPLE FERTILIZERS
(Quelques données pratiques de fertilization du palmier à huile–les engrais simples)

Martin, G. (IRHO, 8, Square Pétrarque, Paris 16e, France), *Oléagineux,* 1977, **32** (12), 519–522.

(In French, English and Spanish)

This advice note is intended to give a few practical tips on the utilisation of simple fertilizers. The nutrient element contents of most commonly used commercial fertilizers, as well as their percentages of certain anions are tabulated.

Since the constituents of some fertilizers may provoke reaction which cause the fertilizing elements to give off gases, or which bring about modification of their physical states, the compatibility of the principal ones is indicated in a second table.

Although many fertilizers have no effect on the pH of the soil, some will acidify or neutralise it and a general indication of some acidifying or neutralising values is indicated in a third table. (IRHO advice note 178).

IS DISBUDDING OF OIL PALM WORTHWHILE?

Rajaratnam, J. A., Chan, K.W., Santheran, K. and Wood. B. J. (Chemara Research Station, Seremban, Malaysia), *Planter, Kuala Lumpur,* 1978, **54**, 176–183.

In view of conflicting opinions concerning the merits of disbudding, eleven published experiments on its effect on cumulative yields from both Africa and Malaysia, were subject to economic evaluation of the net present value (NPV) of the planting, costed up to the eighth year. Standard operational costs were used. No clear economic advantage was shown in short periods of disbudding while long-term disbudding leads to a reduction in NPV. Disbudding done to obtain better vegetative growth does not apparently give yield or profit benefit in most cases. Except to delay crop where a new factory is not ready, or perhaps under exceptionally poor environments, there seems to be no value in the practice. It also acts as a sanitation to restrict pests and disease spread, but there are cheaper ways of doing this.

ASSISTED POLLINATION OF TALL OIL PALMS – MATERIAL USED
(Pollinisation assistée des palmiers à huile de haute taille – matériel utilisé)

Gazzo, A. and Huguenot, R. (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux,* 1978, **33** (4), 161–164.

(In French, English and Spanish)

This note describes the pollination material used for tall oil palms. In countries where trees grow very fast, and where certain natural conditions inhibit the dispersal of pollen, it may be necessary to pollinate on a large scale over a much longer period of time than normal and consequently to conduct these operations at a height much greater than that of an operator. Apparatus is described for crowns situated between 2 and 3.5 m above the ground and for crowns higher than 3.5 m. (This IRHO advice note 182 is a continuation of numbers 111 and 112 of November and December 1971 issues of *Oléagineux*).

Weeds, pests, diseases and their control

RESEARCH ON *Oryctes monoceros* OL. IN THE IVORY COAST. I–BIOLOGICAL CONTROL, ROLE OF THE COVER PLANT
(Recherches sur l'*Oryctes monoceros* Ol. en Côte d'Ivoire. I–Lutt biologique. Le rôle de la plante de couverture)

Julia, J. F. (Entomology Department of IRHO, Port-Bouet Station, Ivory Coast) and Mariau, D. (Entomology Department of IRHO, La Mé Station, Ivory Coast), *Oléagineux,* 1976, **31** (2), 63–68.

(In French and English. Spanish summary, 23 lines)

To avoid *Oryctes* attacks, coconut plantations replacing forest have been planted after felling and complete destruction of the timber which is a potential breeding site for *Oryctes*. This technique has disadvantages and studies have been undertaken to safeguard the organic matter

whilst limiting *Oryctes* attacks. Preliminary trials have been set up to study the role which the cover plant can play when it covers over the windrows rapidly. Plantations realised in accordance with standard methods are compared with those where the timber has been stacked in alternate windrows and more or less quickly covered by the cover plant. When the *Pueraria* only covers the windrows two years after felling, the attacks are very violent (75% of the spears attacked at the same time), and the populations can exceed fifty insects per hectare and per month. When the *Pueraria* covers the windrows one year after felling, the attacks diminish appreciably, but are still not negligible. On the other hand, when the windrows are hidden after 7–9 months, the attacks stay at a very acceptable level.

RESEARCH ON *Oryctes monoceros* OL. IN IVORY COAST. III–OLFACTORY TRAPPING WITH ETHYL CHRYSANTHEMATE
(Recherches sur l'*Oryctes monoceros* Ol. en Côte-d'Ivoire. III–Piégeage olfactif à l'aide du chrysantémate d'éthyle)

Julia, J. F. (IRHO Station, Port Bouet, Ivory Coast) and Mariau, D. (IRHO Station, La Mé, Ivory Coast), *Oléagineux,* 1976, **31** (6), 263–272.

(In French and English. Spanish summary, 23 lines)

A large number of trials have been set up to define the characteristics of the trap and the mode of use. The traps consist of a plastic bucket with a hole pierced in the lid. Inside, a flask is fixed, containing a mixture of ethyl chrysanthemate (2 ml) and an olfactory reinforcer (0.2 ml), (rates for one month's treatment), which evaporates slowly through a wick. The bucket should be placed at 2.5 m from the ground at a density of four traps/ha in staggered arrangement. The rate of capture is extemely variable according to the infestation, the situation of the traps (the ones round the borders capturing more insects) and the state of the breeding sites. If these sites are left bare, the traps capture few insects. By contrast, if they are covered by a cover plant, many more are caught. Thus, the rate of capture can vary from one to four according to the degree of coverage. For *Oryctes*, ethyl chrysanthemate has the same odour as the breeding sites, and the traps therefore attract insects on their way to a site, either coming from another site or after a feeding period. This type of trapping can be used as means of control, but does not completely prevent attacks.

INFESTATION OF THE AERIAL ROOTS OF OIL PALMS BY CATERPILLARS OF THE GENUS *Sufetula* WALKER (Lepidoptera: Pyralidae)
(Infestation des racines aériennes du palmier à huile par des chenilles genre *Sufetula* Walker (Lépidoptère: Pyralidae))

Genty, Ph., (Entomologist of the Ste Industrial Agraria la Palma S.A. (INDUPALMA) A.A. 6226, Bogota, Colombia), Desmier de Chenon, R. (Entomologist at the Institut National de la Recherche Agronomique (INRA), Route de St. Cyr, 78–Versailles, France) and Mariau, D. (Director of the IRHO Entomology Department, B. P. 13, Bingerville, Ivory Coast), *Oléagineux,* 1976, **31** (8–9), 365–370.

(In French and English. Spanish summary, 20 lines)

Several species of the genus *Sufetula* attack the aerial roots of the oil palm in various parts of the world. *Sufetula sunidesalis* in Malaysia and Indonesia, *S.nigrescens* in Africa and *S.diminutalis* in Latin America. These three species have the same behaviour. The caterpillar goes through five differentiated laval stages; it bears long tactile bristles and in the later stages presents lateral and dorsal plates. It lives in the middle of the aerial roots where it weaves a network of silk. The young larva gnaws the tip of the root and penetrates into it to a depth of several centimetres. The infestation can be variable from one tree to another but it is possible to find several hundred caterpillars on one tree, in which case the aerial root system will be completely destroyed. Endrine treatments at an average rate of 0.2% have been proved particularly effective for a year. Apart from the incidence which these attacks may have on yield, it is thought that they might favour the development of *Ganoderma*; zones favourable to the fungus are also those favourable to *Sufetula*. The wounds caused by the caterpillar offer a point of entry to the cryptogam.

A NEW OIL PALM MITE: ERIOPHYIDAE *'Retracrus elaeis* KEIFER'–BIOLOGY, RELATIONSHIP TO ORANGE SPOTTING, EFFECT ON YIELD AND TREATMENTS
(Un novel acarien du palmier à huile: l'Eriophyidea *Retracrus elaeis* Keifer,–Biologie, relations avec l'orange spotting, conséquence sur la production et les traitements)

Genty, Ph. and Reyes, E. (Division Entomologia, INDUPALMA, Bogata, Colombia), *Oléagineux,* 1977, **32** (6), 225–261.

(In French and Spanish. English summary, 14 lines)

A mite of the family Eriophyidae *Retracrus elaeis* Keifer, has been observed for the first time on oil palm in Latin America. The damage it causes, which can be very considerable, takes the form of orange spotting leading to appreciable yield losses and, in the worst cases, very extensive drying of the leaves. It is one of the most harmful cases yet known of orange spotting (usually associated with mineral deficiencies or genetic causes). The mite and the damage it does are described. Effective and inexpensive control has been undertaken with wettable sulphur, a product which has the added advantage of being harmless for the beneficial fauna. Both very great resistance and considerable sensitivity to this organism have been observed in a series of different *E. guineensis x E. melanococca* (syn. *oleifera)* hybrid crosses.

PESTS AND DISEASES OF OIL PALM AND COCONUTS. THE ROOT MINER LEPIDOPTERON, *Sagalassa valida* W.
(Les ravageurs et les maladies du palmier à huile et du cocotier. Les Lépidoptères mineurs de racines, *Sagalassa valida* W.)

Genty, Ph. (Servicio de Entomologia, INDUPALMA, Bogata, Colombia), *Oléagineux*, 1977, **32** (7), 311–315.

(In French, English and Spanish)

The genus *Sagalassa* (family Glyphipterigidae) is represented in Latin America by *S. valada* W. which has adapted itself particularly well to *Elaeis*. After a description and biology of the insect, the damage is described and the need for periodical checks of population levels and how they should be carried out are indicated.

Up to now the best results have been given by Endrin treatment (2 litres/tree of 0.4% solution commercial product for young plants and at 1% for adult trees). Several treatments are needed since Endrin is effective at ground level only and does not reach the larvae inside the deep roots. (IRHO advice note 174).

USE OF HERBICIDE PRODUCTS IN OIL PALM GROWING
(L'emploi des produits herbicides en culture de palmier à huile)

Martin, G. (IRHO, 8 Square Pétrarque, Paris 16e, France) *Oléagineux*, 1977, **32** (11), 479–482.

(In French, English and Spanish)

Various cultivation stages which would justify herbicide treatment are tabulated, indicating the main herbicide products used together with the usual application rates, the average quantity of water per hectare treated and the annual number of treatments. The object of the treatment and the various stages are also tabulated. Furthermore, in a second table, the range of circle areas to be treated in one hectare of oil palm is given as a guide. (IRHO advice note 177).

A NEW METHOD OF CONTROLLING BLAST DISEASE IN THE OIL PALM
(Nouvelle méthode de lutte contre le blaste du palmier à huile)

Desmier de Chenon, R. (INRA, Route de St-Cyr, Versailles, France), Mariau, D. and Renard, J. L. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1977, **32** (12), 511–517.

(In French and English. Spanish summary, 7 lines)

During the last campaign of blast control trials in the Ivory Coast (1976–77), it was possible to reproduce the disease by contaminating plants under cages with the help of insects collected in the neighbouring herbaceous stratum. A new method of control which can replace shading has been found with Temik, a systemic insecticide, applied at the rate of 4 g per plant and per month from October to January.

LARVAL BIONOMY OF [illegible]
JOANNIS

Krishnan, R. (School of Biological Sciences, Universiti Sains Malaysia, Penang, Malaysia), *Planter, Kuala Lumpur*, 1977, **53**, 381–394.

Crematopsyche pendula egg cases and larvae were collected from the field and their biology studied. It was found that an average number of 65 larvae per bag was produced. The larval stages took 29–33 days to complete. Under laboratory conditions, three larval stages (instars) were found, the third instar being the longest. The implications of these and other factors in the control of this bag worm were discussed.

PROTECTION OF *E. guineensis* OIL PALM NURSERIES IN WEST AFRICA AGAINST BLAST
(Protection des pépinières de palmiers à huile *guineensis* contre le 'Blast' en Afrique de l'Ouest)

Desmier de Chenon, R. (INRA, Route de St-Cyr, Versailles, France) *Oléagineux*, 1978, **33** (1), 13–16.

(In French, English and Spanish)

It has recently been shown that blast disease is transmitted by a Homopterid of the Jassidae family. The use of the systemic insecticide Temik in the protection of nursery plants against the disease is described. In view of the high toxicity of the insecticide, its use is strictly limited to nursery and non-food crops and its method of utilisation and the importance of watering in the implementation of this new technique is described. The treatment offers advantages over the standard one of shading the plants in its cheaper cost, simplicity and economy of labour, its protection against several pests other than those that transmit the disease, and the better growth shown by seedlings growing in full sunlight from the time of their installation in the nursery. (IRHO advice note 179).

THE PRINICIPAL OIL PALM DISEASES IN ECUADOR
(Les principales maladies du palmier à huile en Equateur)

Dzido, J. L. (Palmeras de los Andes, Quito, Ecuador), Genty, Ph. (Indupalma, Bogota, Colombia) and Ollagnier, M. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1978, **33** (2), 55–63.

(In French and Spanish. English summary, 11 lines)

Since 1975 the IRHO has been co-operating on the scientific and technical levels with the Palmeras de los Andes Company to gain a more thorough knowledge of oil palm diseases in Ecuador. Apart from a few benign afflictions known the world over, such as crown disease and mild spear rot, (a disease in which rotting only occurs at spear level and from which the palms usually recover without treatment), three diseases were singled out because of their potential destructiveness: marchitez sorpresiva disease, bud rot disease and a new affliction: Ring Spot disease. This article particularly deals with the last-named disease.

LARVAL PARASITES OF *Coelaenomenodera elaeidis* MLK., OIL PALM HISPID IN WEST AFRICA. INTRODUCTION TO A METHOD OF BIOLOGICAL CONTROL

(Les Parasites larvaires de *Coelaenomedera elaeidis* Mlk., hispine du palmier à huile en Afrique occidentale. Introduction à une méthode de lutte biologique)

Mariau, D. (Port Bouet Station, B.P. 7013, Abidjan Airport, Ivory Coast), Philippe, R. (IRHO, La Mé Station, B.P. 13, Bingerville, Ivory Coast) and Lecoustre, R. (SODEPALM, Abidjan, Ivory Coast), *Oléagineux*, 1978, **33** (4), 153–160.

(In French and English. Spanish summary, 13 lines)

The three main larval parasites associated with *Coelaenomenodera elaeidis* are of the Eulophidae family, namely, *Sympiesis arburiana* Waterst., *Pediobius setigerus* Kerrich and *Cotterellia podagrica* Waterst. The biological characteristics of the three are described; details are also given of the parasite spectrum and a comparison is made of the respective efficacity of the parasites according to whether the host is in an endemic or a swarming phase. In view of the relatively narrow spectrum of these parasites and their poor performance when the different host stages occur successively instead of all being present at once, the completion of this parasite 'bank' by the introduction of other species is contemplated. These attempts at introduction will be the subject of further studies.

PROCEEDINGS OF THE THIRD MEETING OF THE INTERNATIONAL COUNCIL ON LETHAL YELLOWING

(Compte rendu de la IIIe réunion de l'International Council on Lethal Yellowing)

Dollet, M. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1978, **33** (4), 165–174.

(In French and English)

On this occasion priority was given to the problems involved in the research on the etiology of lethal yellowing diseases affecting oil palms and coconut. Ten years after the first observation of the first mycoplasma-like organisms under the electron microscope in a diseased plant was reported, the problem of demonstrating the pathogenicity of this type of organism observed in fine section has still not been solved. The programme of the meeting included sessions on the basic biology of yellowing, its diagnosis, the isolation and culture of mycoplasms, vectors, control of the disease and lastly, new problems in oil palm and coconut cultivation. Reference in the latter session was made to 'marchitez sorpresiva' disease of oil palm in Colombia, Ecuador and Peru. In the three countries, there is a specific association between the wilt and a flagellate protozoa, probably a *Phytomonas*. The organisms appear to be identical in their morphology and ultrastructure to those of heart rot disease of the coconut. Fortunately it has been established in 1965 that regular insecticide treatments with Endrin are very effective in combating marchitez disease in the oil palm.

STUDY OF THE ASSOCIATION BETWEEN FLAGELLATE PROTOZOA AND MARCHITEZ SORPRESIVA IN SOUTH AMERICAN OIL PALMS

(Étude sur l'association de protozaires flagellés à la Marchitez sorpresiva du palmier à huile en Amerique de Sud)

Dollet, M. (IRHO, 8 Square Pétrarque, Paris 16e, France), and Lopez, G. (Phytopathology Service, Industrial Agraria La Palma, Ap. Aereo 1535, Bucaramanga, Colombia), *Oléagineux*, 1978, **33** (5), 209–217.

(In French, English and Spanish)

After the discovery of flagellate protozoa in the sieve tubes of inflorescences from oil palms suffering from marchitez disease in Peru, a study with electron and optical microscopes of samples from Colombia, Ecuador and Surinam showed that specific association exists between flagellate protozoa and marchitez disease. The morphology and ultrastructure of these organisms class them in the Trypanosomatidae family probably of genus *Phytomonas*. They move around the sieve tubes through the pores and are found at the first stages of the disease in virtually every organ in the tree. The optical microscope examination of smears coloured with Giemsa or toluidine blue is a good method of diagnosing the disease.

INSECTICIDES AND MITE-KILLERS USED TO PROTECT OIL PALM AND COCONUT CROPS

(Insecticides et acaricides utilisés pour la protection des cultures de palmiers à huile et de cocotiers)

Morin, J. P. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1978, **33** (5), 219–223.

(In French, English and Spanish)

Information on insecticides and mite killers is tabulated. Table 1 lists the products utilised by pest type at the nursery, young plantation and adult plantation stages of cultivation, while Table 2 lists the principal insecticides and mite-killers employed, with an indication of their chemical origins, their toxicity (LD50 in mg/kg for rats by ingestion) and their mode of presentation under some commercial brand names.

EVALUATION OF CARBOFURAN AS A CHEMICAL PROPHYLACTIC CONTROL MEASURE FOR *Oryctes rhinoceros* IN YOUNG OIL PALMS

Toh, P. Y. (Harrisons & Crosfield (M) Sdn. Bhd., Research and Advisory Scheme, Banting, Malaysia) and Brown, T. P. (Sungei Samak Estate, Ulu Bernam, Perak, Malaysia), *Planter, Kuala Lumpur,* 1978, **54**, 3–11.

A marked decline in incidence of young plants damaged by *Oryctes rhinoceros* has been observed with the application of Carbofuran in the granular form (Furadan® 3G) onto palm crowns. Application rates of the order of 0.5 to 1 oz Furadan® 3G per palm at 4–6 week intervals appear adequate. Costs of chemical treatments are detailed.

OWLS AS RAT CONTROLLERS–A PRELIMINARY REPORT

Lenton, G.M. (Zoology Department, University of Malaya, Kuala Lumpur, Malaysia), *Planter, Kuala Lumpur,* 1978, **54**, 72–83.

Barn owls *(Tyto alba)* have been found to feed almost exclusively on three rat pests of oil palm and rubber, namely *Rattus tiomanicus, R. argentiventer* and *R. exulans.* At present a substantial increase in these owls is occurring in Peninsular Malaysia, and with correct management, it seems possible that nest boxes placed within the estates may provide suitable ways of further enlarging the owl population, thus increasing its impact on the rats. The cost of approximately 100 cents per hectare per year is required to install these boxes; a modest outlay for the biological component of an integrated method of control of a serious and costly problem.

CROWN FRACTURE AND PALM TYPE – INITIAL FINDINGS

Duckett, J.E. (Plantation Division, Kuala Lumpur Kepong Berhad, Kuala Lumpur, Malaysia) and Chan, S. K. (Fraser Estate, Kulai, Johore, Malaysia), *Planter, Kuala Lumpur,* 1978, **54**, 142–148.

In D x P palms of ten years old and over, it was noted that an increasing incidence of crown fracture was taking place and, in most cases where this occurred, it resulted in the death of the palm. This paper describes an investigation into a series of such cases on Fraser Estate and the authors postulate that high winds, in conjuction with physical characteristics of certain palms, the effect of leaf base wilt disease, and poor harvesting practices can be major factors regarding the degree of incidence of such crown breakage cases.

Details are given of a method of treatment developed on Bukit Cheeding Estate, Banting, Selangor, that records good levels of recovery which can possibly be further improved on with refinement.

PHYTOSANITARY CHECKS ON ADULT OIL PALM PLANTATIONS IN WEST AFRICA. I.–ORDINARY CHECKS
(Contrôles sanitaires des plantations adultes de palmiers à huile en Afrique de l'Ouest. I.–Contrôles ordinaires)

Morin, J. P. and Philippe, R. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1978, **33** (6), 277–281.

(In French, English and Spanish)

The need is emphasised for checks to be carried out on insect pest populations of oil palm even when the plantation shows no signs of attack, since, under certain conditions, pest populations increase rapidly, causing extensive damage. The definition and work of a phytosanitary surveillance team is briefly described and practical measures for following the movements of teams and to check their work are suggested. (IRHO advice note 184).

Harvesting

F.F.B. HANDLING – AN ASSESSMENT OF SOME OF THE EXISTING PRACTICES

Lim, K.P., Chai, W. (Harrisons & Crosfield (M) Sdn. Bhd., Kuala Lumpur, Malaysia) and Ching, S.L. (Hat Seng Plantations Sdn.Bhd.,Tawau, Sabah), *Planter, Kuala Lumpur,* 1978, **54**, 94–106.

Rising labour costs and shortage of suitable labour are the two main problems in manual f.f.b. handling. The study has therefore been undertaken to investigate three mechanical f.f.b. handling systems in comparison with a manual system. Of the four systems, the mechanical system employing a lorry-crane appears to be the most meritorious. Two other mechanical systems, namely, tractor-crane with tractor-trailers and tractor-crane with lorry, do not seem to have any economic advantage over the manual system, though there is substantial labour saving in the former.

DESIGNING AN F.F.B. TRANSPORT AND HARVESTING SYSTEM

Webb, B. H. and Abdul Rashid Feroze Din (Faculty of Agriculture, University of Malaya, Kuala Lumpur, Malaysia), *Planter, Kuala Lumpur,* 1978, **54**, 191–211.

Oil palm f.f.b. must be harvested quickly and with as little damage as possible to reduce free fatty acid (f.f.a.) to a minimum but at the same time harvesting costs must also be minimised.

here is a wide variation of conditions on oil palm estates nd consequently many different systems have been eveloped. These include lorries, tractor-trailers, railways nd containers for main line transport. The Kulim system as reduced damage and costs while increasing production ates on lorries and tractor-trailers. However, in-field ystems are few and adoption of relatively successful ystems such as the Jackpack, dumptruck or buffalo can ncrease harvesters' outputs by 50–60%.

Costing systems vary considerably and a standard system nust be used for valid comparisons to be made.

To improve harvesting equipment efficiency, correct planning of road and rail networks must integrate with drainage systems.

The design of a suitable harvesting system must consider each estate or scheme on its own merits and it is not possible to recommend a common system for all oil palm plantations.

Evaluation of various systems must use standard time and motion study methods, reducing the measurements to a common production unit such as tonnes per hour.

Future developments must concentrate on the in-field area of the problem and should consider the 'Flying Fox', low pressure 4-wheel drive vehicle or even a hovercraft.

COLLECTION AND TRANSPORT OF F.F.B. FROM PALMS ON AN UNDULATING ESTATE

McIntosh, J. B. (Prang Besar Estate, Kajang, Selangor, Malaysia), *Planter, Kuala Lumpur*, 1978, **54**, 215–219.

In the interest of work output and reduced production cost, there is a growing need to offer assistance to harvesters and collectors in areas of oil palms planted on undulating to moderately steep land. Such terracing affords convenience for field maintenance and allows a rational road system to be planned. All terraces are cut at least once for collecting vehicle access. Harvesters, reluctant to change from conventional to nil carrying of f.f.b., accept the new system which increases in popularity on realisation that reward for comparable effort is no less in spite of reductions in piece rates. Also, higher earnings are available on increased output for some additional effort.

Unfortunately, mechanical shortcomings of the first collecting vehicles resulted in increased overall harvesting costs. However, progressive modifications to the system and machines have resulted in improvement to better than break-even costs against conventional methods. There is obvious scope for further development of collecting equipment and tractors, which must lead to improved unit output and a lower operating cost.

COLLECTION OF OIL PALM BUNCHES IN A PLANTATION – USE OF OX-CARTS

(La sortie des régimes en palmeraie - utilisation des charrettes à boeufs)

Huguenot, R. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1976, **31** (10), 423–426.

(In French, English and Spanish)

The use of ox-carts for transport of f.f.b. and loose fruit from the tree to the collection road has been found to give good results with appreciable economy of labour. The article describes the training, care and use of oxen teams. (IRHO advice note 165).

BUFFALOS ON OIL PALM ESTATES IN MALAYSIA

Dalzell, R. (Unipamol Malaysia Sdn. Bhd., P.O. Box 509, Kluang, Johore, Malaysia), *Planter, Kuala Lumpur*, 1977, **53**, 258–266.

By using buffalo to haul f.f.b. to road collection platforms, a harvester's productivity can be increased by as much as 20%. Buffalos have the advantages of low capital cost, a sale price at the end of their working life equal to or greater than the purchase price, a negligible breakdown time, require no oil fuel and have a long service life. However, the need for planning on both short and long-term requirements before introducing these systems on an estate is pointed out. The merits and demerits of using males, females or steers as working animals are discussed together with selection criteria, availability and price, care of buffalo on the estates and sources of supply.

Palm oil

STUDIES ON AN ALLEGED TOXIC HAZARD OF HEAT-BLEACHED PALM OIL

Davis, J. B., Robinson, J. M., Silva, N. K. and Barranco, A. (Tropical Products Institute, 56/62 Gray's Inn Road, London WC1X 8LU), *J.Fd. Technol.*, 1979, **14** (3), 253–264.

It has recently been suggested that the high-temperature heat-bleaching procedure sometimes used to decolourise palm oil for use in margarine and similar products could lead to the oil becoming contaminated with (unspecified) toxic substances, these being derived by thermal degradation of the orange-red carotenoids originally present. Several of the non-glyceride constituents of such an oil have been identified

as squalene, the major constituent (50%) hentriacontane, various known sterols and triterpenes. These are all common food constituents and degradation products of the type said to be present (C_{40} polycyclic hydrocarbons) have been sought without success. In addition, the degree to which one of the known carotenoid thermal degradation products, namely ionene, is removed from the oil during the usual refining procedure has been measured and the oil's toxicology has been briefly examined. Neither the results obtained by the authors, nor the allied data reported by others and noted in the paper, appear to provide any evidence in support of the above suggestion.

THE CRYSTALLISATION AND DRY FRACTIONATION OF MALAYSIAN PALM OIL

Taylor, A. M. (Van den Berghs and Jergens Ltd., James Watt Dock, Greenock, U.K.) *Oléagineux,* 1976, **31** (2), 73–79.

(In English. French and Spanish summaries, 15 and 14 lines)

This article deals with some of the factors affecting the crystallisation of Malaysian palm oil. Certain parameters are mentioned and graphs showing typical cooling curves obtained on an industrial scale are given. The fatty acid compositions of three batches of palm oil are given, showing the differences in composition and the resultant cooling curves obtained. In addition, the constants and the dilation figures of oleins and stearines produced from the different types of crystalline formation are tabled. The physical characteristics of palm oil and its fractions are touched on and some of the uses to which these products may be put are given. A number of photographs show the different crystalline compositions for each type of cooling curve producing these forms.

INDUSTRIAL FRACTIONATION OF FATS BY CONTROLLED CRYSTALLISATION, TIRTIAUX PROCESS
(Le fractionnement industrial des corps gras par cristallisation dirigée – procédé Tirtiaux)

Tirtiaux, F. (SA Fractionnement Tirtiaux, 601 Chaussée de Charleroi, B 6220 Fleurus, Belgium), *Oléagineux,* 1976, **31** (6), 279–285.

(In French. English and Spanish summaries, 8 and 9 lines)

The principle of directed crystallisation is the basis of edible oils and fats fractionation without solvent or detergent. The process described here, is based on the growth in edible oils and fats of crystals of a certain type followed by their separation on a patented continous filter using a perforated steel belt. The process has large industrial applications in the fields of palm oil, beef tallow, butter oil, hydrogenated fish – and soyabean oil.

OBJECTIVES AND METHODS OF FRACTIONATION OF FATS
(Objectifs et modes du fractionnement des corps gras)

Jacobsberg, B. (Tropical Products Sales S. A., Unilever House, Rue Montoyer 46, 1040 Brussels, Belgium) and Jacqmain, D. (CERIA), Belgian Filtration Society. *Proceedings of International Symposium on Filtration in the Refining and Fractionation of Oils and Fats,* CERIA, Brussels, 28–29 April 1976, pages 119–144.

(In French. English summary, 8 lines)

This paper broadly describes the factors which govern the crystallisation of fats. The compatibility and incompatibility of blends are mentioned, as well as the polymorphism of fat crystals, crystal structure and their link with crystallisation and melting behaviour. The principles of the common analytical methods used to study this behaviour are briefly given.

THE FRACTIONATION OF FATS WITHOUT SOLVENT
(Le fractionnement des corps gras sans solvant)

Hinnekens, H. (Département Recherche et Développement, Oleofina S.A., Brussels, Belgium). Belgian Filtration Society. *Proceedings of International Symposium on Filtration in the Refining and Fractionation of Oils and Fats,* CERIA, Brussels, 28–29 April 1976, pages 145–170.

(In French. English summary, 9 lines)

Crystallisation of fatty materials without the use of a solvent is influenced by the type of raw material, the presence of minor ingredients (mono- and diglycerides), by the agitation and also by the temperature programme. Differential scanning calorimetric analysis and photometric analysis are used in crystallisation measurement methods.

The present paper gives a brief review of the different types of crystallisation equipment as well as of the types of filters used for fractionation without the use of a solvent.

CONTINUOUS STAINLESS STEEL FILTERS IN THE FRACTIONATION OF FATS – TIRTIAUX PROCESS
(Les filtres continus à tole d'acier perforée dans le fractionnement des corps gras – procédés Tirtiaux)

Tirtiaux, F. (Fractionnement Tirtiaux S.A., Fleurus, Belgium). Belgian Filtration Society. *Proceedings of International Symposium on Filtration in the Refining and Fractionation of Oils and Fats,* CERIA, Brussels, 28–29 April 1976, pages 231–259.

(In French. English summary, 15 lines)

The paper presents some specific aspects of fat crystallisation, particularly the characteristics of the

ractionated phases, the influence of the degree of nsaturation on the melting points of triglycerides as well s the considerations of the choice of a discontinuous rystalliser. The Tirtiaux fractionation process is described detail with particular reference to the monitoring of the rystallisation temperature. The final part of the paper gives ne filtration conditions for crystals from oils and fats and escribes the continuous band filter, and the criteria which ecide the choice of this type of filter and its use are given. he fractionation process, without solvent or detergents, or fats with a high palmitic and stearic acid content is onsidered to be a technique with a good future.

ATURE OF SOME CRYSTALLISED DEPOSITS IN LUID PALM OILS

Étude de la Nature de certains dépots cristallisés dans les uiles fluides de palme)

rchier, P. and Bouvron, C. (Laboratoire HSL Blohorn, bidjan, Ivory Coast) *Rev. française Corps Gras,* 1976, 3 (9), 455–457.

n French. English summary, 4 lines)

ome diglycerides present in fluid palm oils obtained by actionation, crystallise slowiy. They are responsible for ne deposits observed in these fluids. These deposits alysed by chromatography, consist exclusively of turated 1, 3 diglycerides.

LM OIL EXTRACTION IN MALAYSIA

non., *Food Engineering International,* 1977, 2 (7), 15.

Belgian firm, S.A. Vanderkerckhove, has signed a ntract to design and build an industrial research unit for traction of palm oil in Malaysia. The project comprises a oduction plant with a processing capacity of 10 tonnes b./hr and a research unit. The production unit will be uipped with a measurement and checking facility with ich it will be possible to test immediately on an lustrial scale, improvements and/or adaptations made in laboratory. In the research section, new types of chines and techniques for improving oil quality can be ted via by-pass lines.

STUDY OF HEATED OILS. I – PREPARATION AND CHEMICAL CHARACTERISTICS OF GROUNDNUT OIL, PALM OIL, SOYABEAN OIL AND SUNFLOWER OIL HEATED AT 220°C

(Étude sur les huiles chauffées. I – Préparation et caractéristiques chimiques des huiles d'arachide, palme, soja et tournesol chauffées à 220°C)

Guillaumin, R., Gente-Jauniaux, M. and Barbati, C. (Institut des Corps Gras (ITERG), Paris, France), *Rev. française Corps Gras,* 1977, 24 (10), 477–481.

(In French, English, German and Spanish summaries, 9 lines)

The four refined oils have been heated to 220°C without adding foods, at the rate of one heating per day during 15 days, i.e. on the whole ten hours at a temperature above 200°C. The thermo-oxidative changes in the oils have been studied during these experiments. A general increase of new chemical species, depending on the polyunsaturation, oxidative past and trace metal content of the oils has been shown. Only very low and not greatly significant increases of the cyclic monomers have been observed, whatever the oils may be.

STUDY OF HEATED OILS. II–TOXICOLOGICAL AND NUTRITIONAL STUDY OF GROUNDNUT OIL, PALM OIL, SOYABEAN OIL AND SUNFLOWER OIL IN THE RAT

(Étude sur les huiles chauffées. II – Etude toxicologique et nutritionnelle chez les rat des huiles d'arachide, palme, soja et tournesol)

Coquet, B., Guyot, D., Fouillet, X. and Rouaud, J. L. (FREB, Les Oncins, France). *Rev. française Corps Gras,* 1977, 24 (10), 483–488.

(In French. English, German and Spanish summaries, 11, 14 and 13 lines)

Rats have been fed a balanced diet containing 15% heated or non-heated oil and 20% protein; the heated oils have been prepared according to Guillaumin's technique (c.f. previous abstract). During the tolerence experiment after 3 months, blood, urine, anatomopathological and histological tests have shown no intolerance to any one of the heated oils. Reproduction tests have shown no anomaly about fertility and growth *in utero.* The young, fed the same diet after weaning, have been killed at 5 weeks old. The autopsy indicates no significant anomaly but only a relative weight of liver and kidneys slightly above those of the controls.

STUDY OF HEATED OILS. III.–CHEMICAL CONSTITUTION OF THERMO-OXIDATIVE ALTERATION PRODUCTS
(Étude sur les huiles chauffées. III. – Constitution chimique des produits d'altération thermooxydative)

Naudet, M. (Laboratoire National des Matiéres Grasse – ITERG, Université d'Aix-Marseille, 13331, Marseille Cedex 3)., *Rev. française Corps Gras,* 1977, **24** (10), 489–492.

(In French. English, German and Spanish summaries, 8, 10 and 9 lines)

Operational conditions required for isolating the thermo-oxidative alteration products selectively, quantitatively, and without structural changes are reviewed. A separation process for these compounds is proposed. This technique enables cyclic and acyclic dimers, estolides, ether bridge-link oligomers, oxymonomers and oxypolymers to be distinguished; the principal possible structures of these compounds are recalled. Examples of seperation are given for different oils.

DEMONSTRATION OF A EUTECTIC MIXTURE BETWEEN PALM OILS AND THEIR FRACTIONS AND LAURIC FATS AND THEIR FRACTIONS. APPLICATION TO THE IMPROVEMENT OF THE COLD STABILITY OF FLUID PALM OIL
(Mise en évidence d'un eutectique entre les huiles et fractions d'huile de palme et les graisses et fractions de grasse lauriques. Application à l'amélioration de la stabilité au froid d'huiles fluides de palme)

Archier, P. and Bouvron, C. (Laboratoire HLS Blohorn, Abidjan, Ivory Coast), *Oléagineux,* 1977, **32** (8–9), 387–390.

(In French. English and Spanish summaries, 7 and 8 lines)

The lauric oils (whole or fractionated) form a eutectic mixture with palm oil or its fractions characterised by a marked improvement of the cold stability of these mixtures. This property, applied to the new industrial products represented by palm oils resulting from fractionation, makes it offer the possibility of using such oils as table oils, even outside tropical countries.

MALAYSIAN PALM OIL FOR CHINA?

Anon., *Public Ledger*, September 7, 1977, 3.

The visit of a five-member palm oil investigation team from China is expected to boost Malaysia's annual sales of palm oil to that country. China purchased 12,632 tonnes of Malaysian palm oil in the first half of 1977.

RAPID METHOD FOR DETERMINING THE PARTIAL GLYCERIDES IN OILS. APPLICATION TO THE STUDY OF TRIGLYCERIDE STRUCTURE OF PALM OIL AND ITS DIFFERENT FRACTIONS
(Mise au point d'une méthode rapide de dosage des glycérides partiels dans les huiles. Application à l'étude de la composition glycéridique des huiles de palme, entière et fractionnées)

Archier, P., Bouvron, C. and Yohou, H. (Laboratoire HSL Blohorn, Abidjan, Ivory Coast) *Rev. française des Corps Gra* 1977, **24** (7), 367–372.

(In French. English summary, 8 lines)

The monoglycerides and the diglycerides in oils are extracted with alcohol and determined by gas liquid chromatography. This method is very rapid and gives in ten minutes the qualitative and quantitative composition of glycerides, with an internal standard.

This method has been used for products obtained by refining and fractionation (in oil phase and solvent phase) of palm oil.

COMPARATIVE STUDY OF THE FRACTIONATION OF OILS FROM *Elaeis guineensis x Elaeis melanococca* (syn. *oleifera*) HYBRIDS
(Étude comparative du fractionnement des huiles issues d'*Elaeis guineensis* et d'hybrides *Elaeis guinennsis x Elaeis melanococca)*

Musso, S., Bouvron, C. Archier, P. and Yohou, H. (Laboratoire HSL Blohorn, Abidjan, Ivory Coast), *Oléagineux,* 1977, **32** (11), 489–491.

(In French. English and Spanish summaries, 8 and 9 lines)

In spite of a high iodine value, the oil of *E. guineensis* x *E. melanococca* (syn. *oleifera*) hybrids is still too rich in solid glycerides to be used as a table oil even in tropical countries. Fractionation of this oil makes it possible to obtain a large output of fluid fraction with a better cold stability than that of groundnut oil and therefore very much superior to that of the oleins obtained from *Elaeis guineensis* oil by the different systems used industrially for fractionation.

STEAM (PHYSICAL) REFINING FOR MALAYSIAN PALM OIL

Gavin, A. M., Teoh, K. T. (Palmex Industries Sdn. Bhd, Prai Industrial Complex, Prai, Penang, Malaysia), and Carlin, G., *Planter, Kuala Lumpur*, 1977, **53**, 229–239.

The production of palm oil is expected to increase by 20% per year during the next five years in Malaysia. Much of this oil will be exported – increasingly in a refined or semi-refined state.

is communication is based on the experiences at the imex Industries Sdn. Bhd. plant located in Penang which s been using the physical refining system. Production cords at this plant confirm the feasibility of physical ining of crude palm oil in Malaysia. It is concluded that properly handled during shipment, oil processed in laysia will arrive in the United States with a minimum of terioration of product quality.

is further concluded that acid-degummed and physically ined palm oil shipped to the USA can be bleached and odorised to produce a product meeting the quality ndards required by American consumers, and that acid-ated, vacuum bleached and physically refined palm oil quires only deodorisation after shipping to the USA to oduce a quality product. The physical refining process is re economical than the caustic refining process.

LM OIL PROCESSING

ushowy, R. H. (Canada Packers Ltd., Toronto, Canada) *Amer. Oil Chem. Soc.*, 1978, **55** (3), 190A–191A.

m oil utilisation is contingent on three key factors – nomic advantage, standards of quality and customer eptance. In order to provide acceptable quality palm oil direct use as part of a formulation, the oil is pre-treated, am refined, bleached and deodorised. A Parkson stripper mployed for steam refining which, with the treatment described, results in yields of the weight of de oil minus 1.19 x the f.f.a. expressed as oleic acid and ished oil colours ranging from 1.0–2.5 red Lovibond ts. Potential colour problems can be avoided by ensuring t all storage and processing conditions are controlled.

ERMAL BEHAVIOUR OF FATS AND OILS. I. – PALM L AND DERIVATIVES
mportement thermique des matières grasses. I. – Huile palme et produits dérivés)

ron, R. and Broncy M. (CNRS, 2 Rue H. Dunant, 94320 ais, France) *Rev. française des Corps Gras*, 1978, **25** 165–173.

French. English summary, 6 lines)

he context of a general study on the relationship veen thermal behaviour and glyceride composition of and oils, a refined palm oil and products derived by resterification, fractionation and hydrogenation have n examined by pulsed NMR and DTA. A methodology applied in order to make the results obtained by these methods comparable.

EXTRACTION OF PALM OIL FROM PRESSED RESIDUE BY SOLVENT

Boyke Loebis (Balai Penelitian Perkebunan (RISPA), Meden, Indonesia) and Everaerts, P. J. (PT. Perkebunan II, Tanjung Morawa, Indonesia), *Oléagineux*, 1978, **33** (4), 179–182.

(In English. French and Spanish summaries, 6 lines)

The most common way to extract palm oil is by the use of presses, especially continuous screw presses. Even under the best conditions, an appreciable quantity of oil is lost in the press cake leaving the presses. The possibility of eliminating this loss by the use of a solvent is discussed. An extraction by a simple series of multiple washings cannot extract all the oil contained in the oily fibre leaving the presses. On the other hand, an extraction preceded by or combined with a separation of water by displacement of its azeotrope with solvent, dries the fibre sufficiently to allow complete extraction of the oil.

POTENTIOMETRIC DETERMINATION OF COPPER IN PALM OIL WITH A COPPER (II) ION-SELECTIVE ELECTRODE

Fung, Y.S. and Fung, K. W. (Department of Chemistry, University of Hong Kong, Hong Kong), *Analyst*, 1978, **103**, 149–155.

The applicability of a copper (II) ion-selective electrode for the determination of copper content of crude and hydrogenated palm oils was investigated. Dry ashing was used for the destruction of the organic matrix and a porcelain crucible was used as the container. The recovery of copper in dry ashing and the leaching of copper from the internal glazing of a porcelain crucible were investigated. A complexing antioxidant buffer was used in order to minimise the interfering effect of iron (III) on the determination of copper (II). A direct potentiometric method can be applied to determine the copper content of palm oil at a concentration higher that 10μ/kg in the presence of 30 mg/kg of iron.

MAJOR ISSUES CONCERNING PALM OIL

Anon., *J. Amer. Oil, Chem. Soc.*, 1978, **55**, 308A–309A.

The Minister of Primary Industries in Malaysia spoke at the International Seed Crusher's Association meeting in Kuala Lumpur and indicated that Malaysian production of palm oil, which exceeded 1 million tonnes in 1975, can be expected to reach around 2.5 million tonnes in 1980 and 4 million tonnes by 1985. The increase in Malaysian palm oil production, together with supplies from other sources,

is likely to raise the current palm oil share in world export of vegetable oils and fats from 13% to approximately 22% in 1985. With regard to the increase in Malaysian production of processed palm oil, he said that the Government had given approval to no less than fifty companies to undertake palm oil processing and that it is estimated that they will produce about 800,000 tonnes of processed palm oil in 1978, 900,000 tonnes in 1979 and nearly a million tonnes in 1980. Palm oil processed in Malaysia currently emerges in the form of neutralised palm oil, neutralised and bleached palm oil, palm olein and palm stearin, with a limited quantity of end products such as cooking oil and vanaspati. It is expected that more of the end products will be produced in the future.

The Minister referred to the establishment of the Palm Oil Registration and Licensing Authority (PORLA) to regulate, co-ordinate and promote activities related to the supply, purchase, sale, storage and shipping of palm oil. He also stated that the Malaysian government is taking steps to establish a Palm Oil Reaseach Institute, the main objectives of which are to provide the means to improve further the efficiency of the palm oil industry and to provide appropriate supportive services for palm oil promotion. Besides consolidating work on production research, the institute is expected to give greater attention to end-use research and to integrate this with more effective market promotion and, in due course, the establishment of a technical advisory service along the lines of the Malaysian Rubber Bureau.

TOCOPHEROLS AND TOCOTRIENOLS IN PALM OIL – CONSIDERATIONS ON THEIR ROLE AS ANTI–OXIDANTS AND PRACTICAL DETERMINATIONS

Jacobsberg, B. (Tropical Products Sales S.A., Brussels, Belgium), Deldime, P. (Ceria, IIF–IMC (Chimie Analytique), Brussels, Belgium) and Abdul Gapor (MARDI, Serdang, Malaysia), *Oléagineux,* 1978, **33** (5), 239–247.

(In English. French and Spanish summaries, 12 lines)

The mechanism of oxidation and the role of tocopherols in fats in relation to the structure, temperature, substrate and concentration is examined. The individual tocopherols in palm oil were identified and their stability was related to heat resistance and to the effect of industrial refining.

It is remarkable that palm oil contains over 60% of tocotrienols, which are not normally present in other edible oils. Although their antioxidant properties are very close to the corresponding tocopherols, they present specific analytical problems. For rapid assessment, differential pulse voltammetry is applicable, provided a correction factor is used for the tocotrienol response and carotene influence is reduced by heat bleaching.

THE MONOUNSATURATED TRIGLYCERIDES OF PALM KERNEL OIL
(Les triglycérides monoinsaturés de l'huile de palmiste)

Moretain, J. P. and Bezard, J. A. (Laboratoire de Physiol de la Nutrition, ENS. BANA, Campus Universitaire, 2100 Dijon, France), *Rev. française des Corps Gras,* 1977, **24** (6 303–314.

(In French. English, German and Spanish summaries, 12, and 17 lines)

The monounsaturated triglycerides of palm kernel oil (12.8% of the total) were isolated by argentation thin-laye chromatography and then fractionated by gas-liguid chromatography into seven groups according to their carb number. From the fatty acid composition of these groups, nineteen triglyceride types were determined and from the 2- monoglycerides formed during enzymatic lipolysis of fi groups, twenty five 2-isomers were determined: the main isomer was lauro-oleo-palmitin (15.8% of the mono-unsaturated triglycerides), followed by lauro-lauro-olein (12.8%) and by lauro-oleo-myristin (9.5%). These twenty five isomers together represent 10.5% of the triglycerides of palm kernel oil.

MANUFACTURE OF PALM KERNEL OIL USING THE TRADITIONAL COCONUT OIL PROCESSING SYSTEM

Banigo, E. O. I., Ogunlesi, A. (Department of Food Technology) and Ofi, O. (Department of Design and Production Engineering, Faculty of Technology, University of Ibadan, Ibadan, Nigeria), *J. Amer. Oil Chem. Soc.,* 1977 **54** (12), 593–594.

The traditional processing system of coconut oil extraction comprising grating of coconut meats, extraction with boiling water, cooling, followed by skimming off the cream and heating it to dryness to give coconut oil, has been adapted for the manufacture of palm kernel oil. Palm kernels were crushed in a laboratory hammer mill, extracted with several lots of boiling water, cooled and the resulting cream skimmed off and heated to dryness to yield palm kernel oil. A comparison of existing traditional and new adapted processing systems showed that the yield of palm kernel oil obtained in both cases was about the same. Furthermore the specific gravity, melting point, refractive index and saponification number were similar, but the moisture content, acid value, colour and odour were dissimilar.

TILISATION OF OIL PALM NUT SHELLS

han, K. C., Goh, S. H. and Tan Wang Ing (University of
lalaya, Kuala Lumpur, Malaysia), *Planter, Kuala Lumpur,*
976, **52**, 127–130.

t is known that oil palm nut shells through destructive
istillation can produce high quality activated carbon,
reosote, phenol, methanol and acetic acid. With the vast
nd increasing quantities of shells becoming available in
lalaysia, a way may be found to undertake commercially
he viable conversion of oil palm nut shells into such useful
roducts. Prospects for the establishment of a new industry
n this basis are reviewed and estimates of ecomomic
enefit to the country are attempted.

OSSIBLE UTILISATION OF BY-PRODUCTS FROM THE ALM OIL INDUSTRY

irkaldy, J. L. R. and Sutanto, J. B. (Department of
hemical Engineering, University of Malaya, Kuala Lumpur,
alaysia), *Planter, Kuala Lumpur,* 1976, **52**, 118–126.

ne potential value of possible by-products from palm oil
ill waste in Malaysia, comprising empty bunches, pericarp
ore, palm shell and effluent, is estimated to be about
80,000,000 annually. It is concluded that the manufac-
re of paper/paperboard/pulp from empty bunches and
tivated carbon from palm shell are the most promising
hough more experimental data is necessary before the
chnical feasibility can be evaluated.

ROBLEMS AND POTENTIAL IN THE TREATMENT OF UBBER FACTORY AND PALM OIL MILL EFFLUENTS

llier, H. M. and Chick, W. H. (Dunlop Estates Berhad,
ala Lumpur, Malaysia), *Planter, Kuala Lumpur,* 1977,
, 439–488.

is paper discusses methods of treatment in general terms.
r rubber, there has been co-ordination by the Rubber
search Institute of Malaysia. Effluents can mostly be
ated to or near to expected legal requirements and there
cope for by-products and land use. No such co-ordination
existed for oil palm effluent, where the industry has
rked separately. Possible treatments and uses exist, and
rit continued development.

LLUTION CONTROL IN THE PALM OIL INDUSTRY ROMULGATION OF REGULATIONS

eswaran, A. and Singam, G. (Ministry of Science,
hnology and Environment, Kuala Lumpur, Malaysia),
ter, Kuala Lumpur, 1977, **53**, 470–476.

total load of biological oxygen demand (BOD) generated
n palm oil processing in Malaysia will, by 1980, be 450 tonnes per day, equivalent to that from a population of 10 million people. Therefore, the Division of Environment of the Ministry of Science, Technology and Environment has given priority to its control. A system of fees and excess charges is to be enforced to encourage some restraint from mid-1978 to mid-1979, and progressively to restrict the discharge by increasingly severe limits on BOD content, in three successive years after that. Land distribution will be allowed, with fees similar to discharge into water courses as if at 5,000 mg/litre. For effluents not actually reduced to that level, special clearance of each scheme will need to be obtained from the Ministry.

Procedures for obtaining licences are outlined.

A REVIEW OF CURRENT METHODS FOR DEALING WITH PALM OIL MILL EFFLUENTS

Wood, B. J. (Chemara Research Station, Kumpulan Guthrie Sdn Bhd, Seremban, Malaysia), *Planter, Kuala Lumpur,* 1977, **53**, 477–495.

Palm oil mill effluent discharge will be regulated in Malaysia from mid-1978. Despite extensive investigations by public and private organisations, no method of meeting the standards exists that is proven on a large scale over a long enough term. Some promising lines are being developed and eventually we can expect a drastic reduction in the pollution load imposed. These lines include animal feed production, digestion and properly controlled land application. Some of them ultimately may even prove profitable.

Training

The Bureau is prepared to advise management in the oil palm industry on the training of personnel. Details of the nationality, linguistic abilities and educational background of the candidate would be needed, together with the purpose for which training is required.

Information

The Tropical Products Institute has one of the world's best libraries of periodicals and works of reference dealing with the products of developing countries and photo-copies of articles dealing with the oil palm can be provided on request. Answers to technical queries concerning the oil palm can also be dealt with; certain agronomic or engineering inquiries might have to be referred outside the Institute, but the Secretary of the Bureau would endeavour to find the best source of information.

In general, no charge will be made for any of the services provided but, if in a specific instance any charge has to be made, the inquirer will be notified in advance before he is committed to any costs.

Inquiries should be addressed to:

The Director
Tropical Products Institute
56-62 Gray's Inn Road
LONDON WCIX 8LU
England

While every effort is taken to ensure that the information in *Oil Palm News* is factually correct, the Oil Palm Advisory Bureau and the Tropical Products Institute are not responsible for views expressed by outside contributors.

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ne following abbreviations are used:

DP Integrated Agricultural Development Project
HO Institute de Recherches pour les Huiles et Oléagineux
ORLA Palm Oil Registration and Licensing Authority

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EDITORIAL

Bottled unrefined palm oil has been on sale in UK and USA stores for many years and mostly purchased by immigrants from West Africa and the West Indies. A report on the laboratory examination of samples recently purchased in the UK and the USA constitutes the 'News Item' for this issue.

A major article on the breeding programme of the Nigerian Institute for Oil Palm Research (NIFOR) by authors who were formerly engaged in this work at the Oil Palm Research Centre, Kade, Ghana, and at NIFOR itself, appears in this issue.

A paper on the glycolipids in Malaysian palm oil, is of interest. Although glycolipids are not found to any extent in palm oil extracted by conventional means, since, together with phospholipids, they are substantially removed during clarification, the traces which remain in the crude oil, called 'gums', may need to be removed by degumming with phosphoric or citric acid prior to further processing, particularly if physical refining is to be carried out.

It is proposed to publish *Oil Palm News* annually from henceforth and the Editor will be glad to receive articles, new items and comments for the 25th and the subsequent issues of *Oil Palm News* as soon as possible.

NEWS ITEM: PALM OILS FROM UK AND USA RETAIL STORES

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Summary

Three brands of unbleached palm oil purchased in the UK and one purchased in the USA were analysed. Three had free fatty acid (f.f.a.) contents of 5.5–5.8% calculated as palmitic acid, as might be expected for unrefined oils, whilst one of the samples purchased in the UK had an f.f.a. of only 0.6% and too low for an unrefined oil. Total carotene contents ranged from 342 to 594 mg/kg. The component fatty acid composition by gas-liquid chromatography of the sample purchased in the USA was close to that found for Malaysian samples in a recent survey by the Palm Oil Research Institute of Malaysia (PORIM) but the samples purchased in the UK all showed lower palmitic and somewhat higher unsaturated acid ratios than the PORIM samples.

Résumé

On a analysé trois marques d'huile de palme non décolorée achetées en Grande-Bretagne et une marque achetée aux Etats-Unis. Trois des échantillons avaient des teneurs en acides gras libres de 5, 5 à 5, 8 pour cent, calculées en tant qu'acide palmitique, comme on peut s'attendre pour des huiles non raffinéas, tandis que l'un des échantillons achetés en Grande-Bretagne avait une teneur en acides gras libres de 0, 6 pour cent et trop basse pour une huile non raffinée. Les teneurs en carotène total étaient de 342 à 594 mg/kg. La composition en acides gras déterminée par chromatographie gaz-liquide de l'échantillon acheté aux Etats-Unis était voisine de celle trouvée pour des échantillons de Malaisie dans une récente étude réalisée par le Palm Oil Research Institute of Malaysia (PORIM), mais les échantillons achetés en Grande-Bretagne présentaient tous un taux plus faible en acide palmitique et un taux quelque plus élevé en acides insaturés que les échantillons de PORIM.

Resumen

Se analizaron tres muestras de marcas de aceite de palmera procedentes del Reino Unido y de una adquirida en los Estados Unidos. Tres de ellas tenían contenidos de ácidos grasos libres equivalentes entre el 5, 5 y el 5, 8 por ciento calculado como ácido palmitico como podría esperarse en los aceites sin refinar, mientras que una de las meustras compradas en el Reino Unido tenía un contenido ácidos grasos libres de solamente 0, 6 por ciento y demasiado bajo para un aceite sin refinar. El contenido total de carotenos osciló desde 342 a 594 mg/kg. La composición de ácidos grasos realizada por cromatografía de gas-líquido en la muestra adquirida en los Estado Unidos fue parecida a la hallada en las muestras procedentes de Malaysia durante un estudio reciente llevado a cabo por el Palm Oil Research Institute (Instituto de investigaciones sobre el aceite de palmera) d Malaysia (PORIM), pero las muestras compradas en el Re Unido mostraron todas niveles palmíticos inferiores y una relaciones de ácidos no saturados algo elevadas, en comparación con las muestras del PORIM.

Unbleached palm oil can be purchased from certain food shops in the UK and the USA, where it is sold for the ben fit of African immigrant populations.

Three samples described as 'Unrefined palm oil' were purchased from shops in the London area whilst a fourth labelled 'Imported West African red palm oil' was purchas in a Washington supermarket and recently received at the Tropical Products Institute through Mr C. W. S. Hartley. All of the samples were bottled in the country of purchas and the brand names and amounts were as follows:

1 Asaria, 396 ml (14 fl oz.). Asaria Foods Ltd, London I

2 Encona, 426 ml (15 fl oz.). Enco Products (London) L London NW5.

3 RTC, 426 ml (15 fl oz.). Khera Trading Co, Wednesbur West Midlands.

4 Sands Brand, 283 g (10 oz.). New York.

The samples were analysed for free fatty acid (f.f.a) and total carotene content by the methods of British Standard 684; Section 2.10: 1976 and Section 2.20: 1977 respectiv with the following results:

Sample no:	1	2	3	4
f.f.a. as palmitic acid (%)	5.8	0.6	5.7	5.5
Total carotene content (mg/kg)	342	515	463	594

Methyl esters were prepared by methanolysis of the oil us 0.5% sodium methoxide in methanol and the component fatty acids determined by gas-liquid chromatography on a 10% DEGS column at 175°C, length 2 m, outside diamete one-quarter inch (6.3 mm).

The component fatty acids of the samples are shown in Tab in comparison with the range found for palm oil in a rece PORIM survey, ('Malaysian Palm Oil Refining Industry',

hnical brochure produced by the Technical Committee the Palm Oil Refiners' Association of Malaysia, 1980, ge 32).

will be noted that the f.f.a. of sample number 2 (0.6%) is o low for unrefined oil and suggests that some refining s taken place in the case of this sample. Samples 1 and 3 ve rather low total carotene contents, that for edible red lm oil of the Codex Alimentarius being 500 – 1,600. This ay be due to the bleaching action of daylight or fluorescent ght while standing on the shelf in clear bottles. It will be rther noted that only sample number 4 has a fatty acid mposition near to that found in the PORIM survey, the her three being notably low in palmitic and somewhat gh in oleic and linoleic acids. This could be because some actionation has taken place before bottling yielding oils richer in the more liquid components or it may be due to a different origin. Bienymé and Servant (1958) examined oils from the African palm belt and noted a higher proportion of unsaturated acids from the Ivory Coast westwards and the fatty acid compositions of all these are not inconsistant with oils of African origin.

Reference

Bienaymé, A. and Servant, M. (1958) Variations des characteristiques des huiles de palme et notamment de leur carotênoides. *Qualitas Plantarum et Materiae Vegetabiles*, **1**, (3/4), 336.

ble 1
mponent fatty acids of palm oil samples

tty acid	Samples				PORIM survey
	1	2	3	4	
uric acid	0.1	0.2	0.09	–	0.1 – 0.4
yristic acid	1.1	1.1	1.1	0.9	0.9 – 1.4
lmitic acid	37.3	37.5	38.9	43.6	41.9 – 46.7
earic acid	5.8	6.4	5.7	5.3	4.3 – 5.1
achidic acid	0.6	0.5	0.5	0.5	0.3 – 0.7
henic acid	0.1	0.07	0.1	–	–
gnoceric acid	0.2	0.2	0.3	–	–
lmitoleic acid	0.5	0.4	0.4	–	0.1 – 0.3
eic acid	40.8	41.0	40.8	39.7	37.3 – 40.5
noleic acid	12.8	11.8	11.4	9.5	9.1 – 10.6
nolenic acid	0.7	0.6	0.6	0.4	< 0.05 – 0.6

DEVELOPMENTS IN OIL PALM BREEDING: A REAPPRAISAL OF PRESENT AND FUTURE BREEDING PROCEDURES IN THE LIGHT OF RESULTS FROM THE NIGERIAN INSTITUTE FOR OIL PALM RESEARCH BREEDING PROGRAMME

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Institute for Horticultural Plant Breeding, Wageningen, The Netherlands (formerly at the Nigerian Institute for Oil Palm Research, Nigeria)

**Coffee Research Station, Ruiru, Kenya (formerly at the Oil Palm Research Centre, Ghana)*

Summary

The results of major oil palm breeding programmes, in particular that of the Nigerian Institue for Oil Palm Research (NIFOR) are reviewed critically with the objective of reconciling the considerable differences in opinion existing between breeders on the mode of inheritance of components of yield and its consequences to breeding strategies in the oil palm. The most important conclusions are:

There are practical and theoretical grounds for using progeny yield data from the early years of production as a basis for the analysis of yield inheritance and the assessment of parental performance.

The largely additive inheritance of all yield components enables the breeder to determine genotypic values of these components for a large number of palms by a minimum number of test crosses.

When breeding for higher bunch yields, selection should be based on the two components, number of bunches and single bunch weight, as these are both mainly additively inherited, in contrast to overall yield of fresh fruit bunches which shows a high non-additive variance. This is not due to a high incidence of specific combining ability, but to deviations from additivity caused by yield being the product of two additively inheriting yield components: yield = number of bunches x single bunch weight.

In selecting parents for seed production, one should aim at maximum yield transgression by combining parents with contrasting yield components.

The concept of inter-origin crosses in the oil is misleading and it has been demonstrated that yield transgression is not restricted to Deli x African crosses.

Continued exploitation and adaptation of the inbred Deli population as a source of high bunch weight genes appears unjustified.

Oil palm breeding will benefit most from further intensive exploitation of the West African centre of genetic variation, making optimum use of the available additiv genetic variation and possibilities of yield transgressior by creating base populations with contrasting yield components.

The high heritability of the fruit quality components justifies phenotypic selection, but the consequences fo selection of the lack of correlation of shell and mesoca to fruit between *dura* parents and their *tenera* offsprin tend to be overlooked.

Fibre content in the mesocarp has a higher heritability than oil content; a simple and effective indirect oil analysis procedure can be based on this fact.

Further detailed analysis of growth and yield factors m eventually lead to palms adapted to higher planting densities; it may also provide a sound basis for nursery selection.

The introduction of clonal propagation is likely to revolutionise breeding and seed production practices. I would also help the breeder to obtain more accurate information on the heritability of all factors contributi to yield and in the interactions between genotype, age and environment with respect to these factors. This would enable him to define exactly when, where and o what parameters selection is best carried out.

The perspectives of interspecific hybridization between *Elaeis guineensis* and *E. oleifera* are mentioned.

Résumé

Les résultats des principaux programmes de sélection du palmier à huile, en particulier de celui du NIFOR, ont fait l'objet d'une analyse critique en vue de concilier les importantes différences d'opinion existant entre les producteurs en ce qui concerne le mode de transmission héréditaire des composantes de productivité et ses conséquences pour les programmes de sélection du palmie à huile. Les conclusions les plus importantes sont les suivantes:

Il existe des raisons pratiques et théoriques d'utiliser les données concernant la productivité des descendants des premières années de production comme base pour l'analyse de l'héritabilité de la productivité et l'évaluation des performances parentales.

Le caractère largement additif de la transmission héréditaire de toutes les composantes de productivité permet au sélectionneur de déterminer les valeurs génotypiques de ces composantes pour un grand nombre de palmiers à l'aide d'un nombre minimal de croisements de test.

Lors d'une sélection pour des rendements plus élevés en régimes, la sélection doit être basée sur les deux composantes, nombre de régimes et poids unitaire des régimes, étant donné que les deux sont héritées de façon essentiellement additive, contrairement au rendement global de régimes de fruits frais qui présente une variation non-additive élevée. Ceci n'est pas dû à une incidence élevée de capacité de combinaison spécifique, mais à des écarts par rapport à l'additivité dûs au fait que le rendement est le produit de deux composantes de productivité à transmission héréditaire additive: productivité = nombre de régimes x poids unitaire des régimes.

Dans la sélection de parents pour la production de graines, on doit rechercher une transgression maximale de la productivité en combinant des parents avec des composantes de productivité opposées.

Le principe des croisements inter-origine dans le palmier à huile est fallacieux et il a été démontré que la transgression de productivité ne se limite pas aux croisements Deli x Africain.

Une exploitation et une adaptation continues de la population naturelle de Deli comme source de gènes de régimes de poids élevé semblent injustifiées.

La sélection du palmier à huile tirera le maximum de profit de l'exploitation intensive plus poussée du centre de variation génétique Ouest-Africain, en utilisant de façon optimale la variation génétique additive existante et les possibilités de transgression de la productivité en créant des populations de base avec des composantes de productivité opposées.

L'héritabilité élevée des composantes de la qualité du fruit justifie la sélection phénotypique, mais les conséquences de l'absence de corrélation de l'enveloppe et du mésocarpe au fruit entre les parents *dura* et leur descendance *tenera* pour la sélection tendent à être négligées.

La teneur en fibres du mésocarpe a une héritabilité plus élevée que la teneur en huile; un procédé d'analyse indirecte de l'huile, simple et efficace, peut être basé sur ce fait.

Une analyse détaillée plus poussée des facteurs de croissance et de productivité peut éventuellement conduire à des palmiers adaptés à une densité de plantation plus élevée; elle peut également fournir une base solide pour une sélection en pépinière.

L'introduction de la propagation par clônes est susceptible de révolutionner les pratiques de sélection et de production de graines. Elle aiderait également le sélectionneur à obtenir des informations plus précises sur l'héritabilité de tous les facteurs contribuant à la productivité et sur les interactions entre génotype, âge et environnement en ce qui concerne ces facteurs. Cela lui permettrait de préciser avec exactitude le moment, l'endroit et les paramètres de base pour procéder à la sélection dans les meilleures conditions.

Les perspectives de l'hybridation inter-spécifique entre *Elaeis guineensis* et *E. oleifera* sont mentionnées.

Resumen

En el artículo se revisan de modo crítico los resultados obtenidos a través de los programas de cultivo de palmeras oleaginosas más importantes – particularmente el de NIFOR – con el objeto de conciliar las considerables diferencias de opinión existentes entre los cultivadores, en torno al modo de herencia de componentes procedentes de la cosecha y de sus consecuencias en relación con los métodos de cultivo de palmeras oleaginosas. Las conclusiones más importantes son:

Existen razones prácticas y teóricas para usar los datos de rendimiento de progenie pertenecientes a los primeros años de producción como base para el análisis de herencia de rendimiento y la evaluación de la capacidad de las plantas matrices.

La herencia principalmente aditiva de todos los componentes de la cosecha permite al cultivador establecer los valores genotípicos de dichos componentes para un gran número de palmeras con un número mínimo de pruebas entrecruzadas.

Cuando se tratan de obtener cultivos para cosechas de racimos mayores, la selección deberá basarse sobre los dos componentes, el número de racimos y el peso de cada individual, ya que ambos son heredados principalmente de forma aditiva, en contraste con la cosecha total de racimos de fruta fresca, la cual muestra una elevada variación no aditiva. Esto no se debe a una elevada incidencia de abilidad combinadora específica, sino a desviaciones procedentes de aditividad debidas a causa de que la cosecha constituye el producto de dos componentes de rendimiento heredado de modo aditivo: rendimiento = al número de racimos multiplicado por el peso de cada racimo individual.

Al seleccionar las plantas madre para la producción de semillas, deberá concentrarse en obtener una transgresión

máxima de cosecha mediante la combinación de plantas madre con los componentes de rendimiento contrastantes.

El concepto de cruzamientos interoriginales en el cultivo de palmeras oleaginosas es engañoso, habiéndose demostrado que la transgresión de cosecha no se halla limitada a los cruzamientos Deli x Africanos.

La explotación y adaptación constante de la población endógama de Deli como fuente de genes de elevado peso de racimo parece ser injustifacada.

El cultivo de palmeras oleaginosas se beneficiará principalmente de una mayor explotación intensiva del centro de variación genética del Africa Occidental, haciendo un uso óptimo de la variación genética aditiva disponible y de las posibilidades de transgresión de cosecha, al crear poblaciones base con componentes de rendimento contrastante.

Lás elevadas posibilidades hereditarias de los componentes de calidad de la fruta justifican la selección fenotípica, pero las consecuencias de la falta de correlación entre la vaina y el mesocarpio con referencia a la fruta entre plantas madre *dura* y sus brotes *tenera* con referencia a la selección tienden a ser pasadas por alto.

El contenido fibroso en el mesocarpio posee unas posibilidades hereditarias mayores que la del contenido oleaginoso; un método de análisis oleaginoso indirecto sencillo y eficaz podrá basarse en este hecho.

Un análisis ulterior detenido de los factores de desarrollo y rendimiento podrá con el tiempo resultar en palmeras que se adapten a unas densidades de plantación más, elevadas, pudiendo también facilitar una base firme para la selección de viveros.

La introducción de propagación clonal puede que revolucione los métodos actuales de cultivo y producción de semillas. También ayudará al cultivador a obtener una información más precisa en torno a las posibilidades hereditarias de todos los factores contribuyentes al rendimiento, y sobre las acciones recíprocas entre el genotipo, la edad y el ambiente referente a estos factores. Esto le permitiría una definición exacta sobre el momento, lugar y tipo de parámetros para efectuar la mejor selección.

Se mencionan las perspectivas para la hibridización interespecífica entre *Elaeis guineensis* y *E. oleifera.*

Introduction

Present developments in oil palm breeding are necessarily based on experience gained in the past. Particularly in a crop with such a long generation cycle (8–9 years), where most breeders are working on genetic material inherited from their predecessors, a thorough understanding and critical assessment of past breeding procedures is essential.

The long generation cycle and the lack of continuity in several major oil palm research centres are responsible fo the fact that only a few comprehensive breeding progra have been continued long enough to provide the genetic information on which a sound breeding policy for the fu can be based. Some programmes have been going on for a time but had a rather narrow genetic basis in their early stages, e.g. the Sumatran and Malaysian programmes base on the Deli *dura* (Hartley, 1977). Others had to be disco tinued before they had come to full fruition. They have nevertheless contributed important information which ha since been made use of extensively in more recent programmes. We need only mention the pioneering work on shell thickness inheritance by the Institute National pour l'Etude Agronomique du Congo (INEAC), (Beirnaert and Vanderweyen, 1941) in the Congo (now Zaire) and the early studies of Deli x African *tenera* populations by the Algemene Vereniging Rubberondernemingen ter Oostkust van Sumatra (AVROS) (now Research Institute of the Sumatra Planter's Association (RISPA)) in Sumatra (Pron and Westenberg, 1955).

Of the programmes incorporating a wide range of genetic material only the Institute de Recherches pour les Huiles e Oléagineux (IRHO) programme in Ivory Coast, (Gascon *et al.*, 1966), the Nigerian Institue for Oil Palm Research (NIFOR) programme in Nigeria (Sparnaaij *et al.*, 1963) an some more recent Malaysian programmes (Hardon, 1976) are sufficiently comprehensive to provide a basis for genet interpretation.

Exchange of information and plant material between these breeding centres has been an important feature right from the early stages. As expected, the results obtained are not very different and, taken together, they should provide a sound basis for the formulation of a future breeding policy Unfortunately, the interpretation of the results is not alwa consistent and in particular there are considerable differenc in opinion between the successive authors reporting results of the NIFOR programme (Sparnaaij, 1969; van der Vosse 1974; West *et al.*, 1976). This is very confusing for present day oil palm breeders and seriously reduces the impact of the NIFOR work on future oil palm breeding. In this pape we shall try to reconcile these conflicting views, or at least indicate how they have arisen, so as to enable oil palm breeders to make better use of the available body of information.

There is general agreement about the procedure for improv ment of fruit and bunch quality based on the additive inheritance of the fruit composition characters, although the implications of the low correlation between *dura* and *tenera* siblings are not yet generally appreciated. Breeders also agree about the strong environmental influence on individual bunch yield performance and the consequent need to base selection on the results of test crosses.

However, no agreement has been reached on the value of the early years of production for yield selection and on th relative importance of additive and non-additive genetic variance of bunch yield and its components. It is clear tha

's views on these points directly influence the duration of eeding cycle and the crossing scheme adopted.

eders also differ in their interpretation of the value of li *dura* palms and the role of heterosis versus consanguinity oil palm breeding. This influences their criteria for ection of new breeding parents.

lection should be based on early yields?

lative progeny performance in the early years of pro- ction is not the same as at maturity. It has been demon- ated in Nigeria (Blaak, 1965; Sparnaaij, 1969) that at a ndard density of 148 palms/ha, the first 3 years of pro- ction are little influenced by mutual competition. As the rly years without competition will be a relatively minor rtion of the total lifespan of a commercial plantation, ost breeders tend to base selection for yield on mature elds. Though this is a safe procedure, it is also a costly e as it requires an additional 3–4 years before seed trees n be chosen and a new cycle can be initiated.

decide which selection procedure is the most effective, must try to understand why mature progeny performance different from early progeny performance. With creasing age, number of bunches decreases and single nch weight increases. The decline in number of bunches ens out after 3–4 years; the single bunch weight continues increase for a much longer time, depending on the degree competition. Particularly under marginal conditions, mpetition for water and nutrients may set in at a relatively rly age and limit the increase of single bunch weight and ereby its variance. In more favourable areas, where palms oduce a greater mass of leaves, competition for light may come apparent in a reduction in number of bunches and variance. Some experimental evidence was obtained from comparison between the outer and inner rows of the FOR progeny trials which had been planted according to four-row planting system in which every fifth row is t unplanted. Blaak (1971) found a 110–145% increase bunch yield for outer-row palms over inner-row palms a number of high yielding progenies for the 6–7th year production. This was particularly due to an increase in mber of bunches, also to somewhat heavier bunches. st (1976) found also higher yields for outer rows for ne progenies.

rther research on the relationship between genotype, age environment is necessary before we can explain the ious forms of competition. For the time being we must ume: (i) that progenies react differently to various forms competition; (ii) that the nature and degree of compe- on is specific for a certain environment; (iii) that, sequently, relative progeny performance at maturity l be different at different sites and (iv) that relative geny performance in the early years gives a better pression of the maximum yield potential of the progenies.

r view can be summarized as follows: selection at turity will lead to progenies suitable for the particular environment under which the selection takes place. It is to be recommended for plantation companies serving only their own needs. Early selection under relatively competition-free conditions leads to precocious progenies with a high maximum yield potential. It is to be recommended for breeding centres serving widely different climatic areas.

A high yield potential may make a genotype more sensitive to competition and lead to a disappointing performance under marginal conditions. On the other hand there is a constant advance in agronomic research aimed at allowing the plant material to realize a larger proportion of its yield potential. This means that, in particular with respect to selection of parents for a new generation of the breeding programme, it is likely to be more effective to aim at an increase in yield potential than at higher yields at maturity under contemporary and local agronomic practices.

One possibility of making better use of the yield potential of modern oil palm material, at present under investigation in Ghana (van der Vossen, 1974), is a combination of relatively close spacing in the early years of production followed by a reduction in plant density by systematic thinning at maturity.

Inheritance of components of yield

Bunch yield

In mature plantings, the yield ceiling, imposed by the environment and the mutual competition, causes a strong negative correlation between the yield components, number of bunches and single bunch weight. This results in an increase in the non-additive interaction effects in the variance of the yield components. As the number of bunches is determined at a much earlier stage than single bunch weight, it is less efficient in adjusting overall yield levels to the prevalent conditions. This explains why the number of bunches shows a lower non-additive variance component than single bunch weight in the most recent analysis of the NIFOR data presented by West *et al.* (1976). In this analysis, additive variance nevertheless remains the most important variance component for both number of bunches and single bunch weight as was the case in an earlier analysis by van der Vossen (1974). For overall yield of fresh fruit bunches the non-additive variance component is much larger and in several instances as important as the additive component. This is particularly clear in the *dura* x *tenera* and Deli *dura* x *tenera* crossing programmes, i.e. in material comparable with modern planting material. The very low estimates of heritability, found by van der Vossen (1974) for overall yield, indicate that this situation already existed in the early years of production of these plantings.

The conclusion proposed by West *et al.* (1976) is 'that for two of the three yield characters, yield of fresh fruit bunches and single bunch weight, the additive model does not explain all the variations: there being in the majority of the analyses highly significant interaction effects as well as parental effects'. They see this as 'a confirmation of the argument put forward by Meunier and Gascon (1972) and Gascon *et al.* (1976) that any form of selection based on

the performance of the parent, which only takes into account the additive genetic variance, neglects the considerable advances that can be made by utilizing specific combining ability'.

The high levels of non-additive variance for yield of fresh fruit bunches are illustrated by West *et al.* (1976) by a list of progenies widely deviating from the yield levels predicted on the basis of the additive model. West (1976) presents these as proof that there exists a fairly complex pattern of inheritance, much more complex than suggested in earlier publications of data from the same programme (Sparnaaij, 1969; van der Vossen, 1974).

Most of the deviations from additivity quoted by West (1976) and West *et al.* (1976) are seriously inflated due to their being derived from combined analyses of two different trials with unequal average yield levels. But even if they were not, they should not be compared with earlier data as they relate to overall yield of fresh fruit bunches and overall yield was not used in our earlier publications (Sparnaaij, 1969 and van der Vossen, 1974) as a parameter for the interpretation of yield inheritance.

In our concept of yield inheritance, overall yield, being the product of the two yield components, number of bunches and single bunch weight, will inevitably show considerable deviations from additivity, even when both yield components are inherited in a purely additive manner. These deviations are predictable in contrast to deviations due to unpredictable specific combining ability.

In the young plantings we studied at the time, both yield components actually proved to be mainly additively inherited . We could therefore conclude that the genotypic value of individual parents can be determined on the basis of a few test crosses and the yield of other non-tested combinations can be predicted from genotypic values of the parents for the two yield components. The highest yields would be obtained by combining parents with the most contrasting yield components.

The picture emerging from the analysis by West *et al.* (1976) of the later data from the same progeny trials, is in fact less complex than we had assumed and very much in agreement with our earlier concept. In these mature plantings the additivity of the two yield components has remained remarkably high in relation to non-additive variance so that, contrary to our expectations, our procedure for calculating genetic values and predicting yield of parent combinations would still be valid. This does *not* mean, however, that the relative genotypic values for the parents and the best parent combinations will always be the same as in the early years.

The difference between West's analysis and ours is thus only in the interpretation. West emphasizes the lack of additivity in the overall yield data. He advises plant breeders to try and discover cases of specific combining ability by planting as many combinations as practicable between a limited number of parents. We emphasize the largely additive inheritance of the two yield components (see also Hardon 1976) and conclude that breeders should make full use the wide additive variability that is still available by (i) testing as many promising parents as possible in the min number of combinations required for the determination genotypic values and (ii) exploiting the possibilities of transgression by combining parents with contrasting yie components. Only at later stages of breeding, when mo additive variance has been exhausted, may an analysis of variance based on overall yield be more rewarding than a analysis of the two components. This situation appears have been reached in the Deli material in Malaysia.

Components of bunch and fruit quality

There is a general consensus on the strictly additive mod inheritance of the bunch and fruit quality components i the oil palm. Heritability estimates derived from the regression of genotypic values on phenotypic values or offspring-parent regressions, all within the *tenera* fruit ty presented by West *et al.* (1976) compare very well with those published earlier by van der Vossen (1974). The component fruit-to-bunch ratio appears to have a low heritability, but the high h_n^2 (heritability in the narrow sense) values for the fruit quality components mesocarp-, shell- and kernel-to-fruit ratios found in the NIFOR breed population within the same fruit form, *tenera* or *dura*, indicate that rapid progress can be made from phenotypic mass selection. However, there is generally a low correlat for the fruit quality components, mesocarp and shell, between *dura* and their *tenera* offspring or between *dura* and *tenera* full-sibs (Sparnaaij, 1969; van der Vossen, 197 During a prospection for oil palm germ plasm in eastern Nigeria, a similar lack of correlation was observed betwee shell thickness of *duras* and *teneras* of the same site (Hart 1977). This explains why West *et al.* (1976) obtained low heritability estimates for the mesocarp- and shell-to-fruit ratios from the regression of *tenera* offspring on Deli *dura* parents.

The implications are that the *tenera* genotypic values of mesocarp and shell for *dura* palms can only be reliably estimated from their *tenera* offspring or from the mean of *tenera* full-sibs.

West *et al.* (1976) found the oil-to-mesocarp data from the NIFOR progenies to be unreliable because of various deficiencies in the methods of oil analysis and were therefore unable to study the inheritance of this character. Van der Vossen (1974) came to similar conclusions and used instead only oil analysis data obtained from NIFOR progenies planted at the Oil Palm Research Centre (OPRC) in Ghana for his inheritance studies of mesocarp oil and dry fibre content. The considerable seasonal variation in mesocarp oil content (Blaak *et al.*, 1963; van der Vossen, 1974) and the low h_n^2 (Meunier *et al.*, 1970; van der Vosse 1974) make multiple measurements per palm and per progeny necessary to obtain reliable estimates of genotypi values for this important component of yield in the oil palm. A considerable reduction in oil extraction work ca be achieved by the application of a modified indirect method of oil determination which is based on the fact th

n the mesocarp, the percentage oil = 100 – dry fibre ercentage – water percentage. The dry fibre content of he mesocarp has a much higher h^2_n (van der Vossen, 1974) han the oil content and progeny averages can be deter-nined accurately from a limited number of bunches har-ested even during the first year of production. Such early unches are normally unsuitable for direct oil-to-mesocarp r moisture determinations. In the second and later years f production, simple moisture determinations on fruit amples from a larger number of fully ripe bunches will rovide the additional information required to calculate eliable oil-to-mesocarp figures per progeny.

ources of breeding material

n most breeding programmes a prominent place has been iven to the Deli *dura* x African *tenera* cross because of he relatively good performance of this combination. This usually attributed to the favourable influence of com-ining two distinct populations with different characters. his view is reinforced by the fact that there are many xamples of inbreeding effects in the oil palm, such as the oor performance of many – though certainly not all – opulations from selfings. Hardon (1970) believes that he performance of the Deli x African cross can be quan-itatively explained on the basis of the inbreeding coef-icients of the two parent populations. However, in view f the inconsistency of inbreeding effects observed in selfings, is unlikely that inbreeding coefficients could be used to alculate the expected performance of combinations etween individual parents that have undergone varying egrees of inbreeding. The only safe assumption one can ake, is that inbreeding (consanguinity) will in certain ases make yield levels fall below those expected on the asis of additivity of the yield components.

he Deli palm has been subjected to several generations of reeding to adapt it to the South East Asian conditions, here it exhibits the ideal combination of an adequate umber of bunches and a high single bunch weight. Under frican conditions the Deli palm is of below average pro-uctivity due to the very low number of bunches, which not fully compensated by its heavier bunches. Com-nation, in crosses, with the African material with its ontrasting yield composition (more but lighter bunches) sults in an overall yield level exceeding that of either arent. This is directly attributable to the mainly additive heritance of both yield components. In the progeny ese components reach levels which are intermediate tween those of the two parents as can be demonstrated the following numerical example:

	Number of bunches		Mean bunch weight (kg)		Yield (kg)	
eli parents	5	x	17	=	85	average 88
rican parents	13	x	7	=	91	
eli x African crosses	18/2	x	24/2	=	108	

This trangression effect had been clearly demonstrated in earlier results by Pronk and Westenberg (1955) and by Gascon *et al.* (1966) and more recently from the data of the NIFOR breeding programme by van der Vossen (1974).

It is therefore surprising that the excellence of the Deli x African cross continues to be ascribed to a kind of heterosis effect resulting from the combination of two distinct origins instead of to a simple and predictable transgression. In our view this is not just an academic question. It has led to the idea that the different origins should be kept pure to avoid consanguinity and that further breeding work should be done within the Deli *dura* to create even better combiners with African *tenera* and *pisifera* (Gascon *et al.*, 1976). Though this may be a sound short-term solution, it unnecessarily prolongs the dependence on the inbred Deli population with its narrow genetic basis and its limited scope for further improvement. Subjecting it to breeding and selection under African conditions would reverse the process of selection that has been going on for more than a century in Asia to adapt these originally African palms to Asian conditions. It would seem much more logical to start a programme of selection for a higher single bunch weight within the African material.

The large *dura* x *tenera* plantings at NIFOR, in which the same *tenera* parents were crossed with both African and Deli *dura,* allow a direct comparison of inter-origin with pure Nigerian crosses (yield data from NIFOR Annual Reports). The combinations were in all cases made according to the schedule of compensatory crosses (Sparnaaij *et al.*, 1963) which, in the case of yield factors, meant that parents with many small bunches were usually combined with others having fewer, heavier bunches. The results are quite illustrative. For each of 15 *tenera* parents we compared the average production level of their African *dura* x *tenera* progenies and their Deli *dura* x *tenera* progenies of comparable age and situation; a total of 68 progenies was involved. For 2 of the 15 *tenera* parents no difference was found, for 5, their Deli *dura* x *tenera* progenies yielded better and for 8, the African *dura* x *tenera* progenies were more productive. Similar indications can be obtained from the lists of progenies (West, 1976) exceeding the standard cross in the *dura* x *tenera* trial. Of the 31 progenies in one trial there are only 10 of pure African origin. Four of these are among the seven highest yielding progenies listed. Of the 30 progenies in the other trial, there are 11 African progenies; Among the 8 best yielding progenies there are 5 purely African ones.

Many first generation NIFOR progenies, resulting from crosses between phenotypically chosen parents, compare favourably with proven high-yielding progenies from IRHO and INEAC, planted in the same trials as standards. A direct comparison of extension work seed from the three sources led to a similar conclusion (NIFOR Annual Reports). We therefore firmly believe that the Nigerian palm groves are the best known source of genetic material for future breeding.

Future developments

Oil palm breeding in the near future will benefit most from further intensive exploitation of the West African centre of genetic variation, making optimum use of the available additive genetic variance and possibilities of transgression by creating two base populations of *tenera* parents with contrasting yield components (van der Vossen, 1974; Hardon, 1976).

The importance of growth analysis in oil palm selection has been emphasized by Corley *et al.* (1971) and Hardon *et al.* (1972). They developed methods of estimating growth parameters from non-destructive measurements and indicated that it should be possible to improve, by selection, the relative distribution of dry matter production to reproductive and to vegetative growth. Whether this should lead to palms that are more tolerant to competition, (Hardon, 1976), and therefore suitable for planting at higher densities, (Corley, 1973), depends on the amount of additive genetic variation present for these growth parameters. There is therefore a need for similar growth analysis work to be carried out under the more variable environmental conditions of West Africa. If, in current breeding programmes, any close correlation can be found between certain growth parameters and the major yield components, this might provide a sound basis for selection in the nursery.

The development of practical methods of vegetative propagation through tissue culture, (Jones, 1974; Corley *et al.*, 1977), may eventually lead to completely different breeding techniques – more akin to those developed for rubber for example. It is more likely, however, that vegetative propagation will be used mainly to create clones of parent trees and that commercial planting material will continue to be grown from seed. In a system based on vegetative propagation of parent trees, early assessment of the genotypic values of many individual parent palms is even more important than in the present situation.

Clonal trials in different environments would be more efficient than progeny trials in providing information on variation in growth and yield parameters under the influence of genotype, age and environment and on the interactions between these factors. This would enable the breeder to define more accurately at what age, under what conditions and on what parameters selection is best carried out.

The availability of clones from a number of different genotypes will also greatly facilitate a more detailed genetic analysis of the least heritable components of oil yield. The character fruit-to-bunch (f_b) is a component of both the oil extraction percentage (oil-to-bunch = oil-to-mesocarp x mesocarp-to-fruit x fruit-to-bunch) and the single bunch weight (weight = fruit + stalk + spikelets, with fruit accounting for 50–70 % of bunch weight). The low heritability of f_b limits the effect of selection on oil extraction percentages. It is also likely to be responsible for deviations from additivity in the factor single bunch weight, suggesting that it may be more effective to select on the parameter 'stalk + spikelets' than on single bunch weight.

Fruit-to-bunch is itself a complex yield component and the product of a number of factors that should be considered separately: number of spikelets per bunch, number of flowers per spikelet, number of fruits per flower (fruit set) and single fruit weight. Concentrating selection on the most heritable components, presumably number of spikelets and number of flowers per spikelet, rather than on the complex factor f_b, may considerably accelerate selection progress.

Selection of individual *pisifera* pollen parents would also greatly benefit from the identification of the most heritable yield components that can be observed in a sterile *pisifera* palm.

In the more distant future, the promising perspectives of interspecific hybrids with *E.oleifera* may be realised (e.g. improved oil quality and disease resistance, Meunier and Hardon 1976). This will only be the case, however, if a sound basis can be developed for selection within the *E. oleifera* population, leading to parents having a good general combining ability with *E. guineensis* breeding parents. It is unlikely that a programme of back-crosses to *E. guineensis* will lead to practical results within a reasonable period of time, in view of the expected segregation of most characters, contrasting sharply with the high degree of uniformity and general vigour of the F_1 hybrid generation.

References

Beirnaert, A. and Vanderwyen, R. (1941) Contribution à l'étude génétique et biométrique des variétés d'*Elaeis guineensis* Jacquin. *Publication Institute National Agronomique. Congo Belge. Série scientifique 27,* 101 pp.

Blaak, G. (1965) Breeding and inheritance in the oil palm *(Elaeis guineensis* Jacq.) part 3: yield selection and inheritance. *Journal of the Nigerian Institute for Oil Palm Research.* **4**, 262–283.

Blaak, G. (1971) Some notes on developments in the NIFOR breeding programme. *Mimeo,* 21pp.

Blaak, G., Sparnaaij, L. D. and Menendez T. (1963) Breeding and inheritance in the oil palm *(Elaeis guineensis* Jacq.) part 2: Methods of bunch quality analysis. *Journal of the West African Institute for Oil Palm Resarch,* **4**, 146–155.

Corley, R. H. V. (1973) Effects of plant density on growth and yield of oil palm. *Experimental Agriculture,* **9**, 169–180.

Corely, R. H. V., Hardon, J. J and Tan, G. Y. (1971) Analysis of growth of the oil palm (*Elaeis guineensis* Jacq.). 1. Estimation of growth parameters and application in breeding. *Euphytica,* **20**, 304–315.

Corley, R. H. V., Barret, J. N. and Jones, L. H. (1977) Vegetative propagation of oil palm via tissue culture. *Oil Palm News,* (22), pp. 2–7.

Gascon, J. P., Noiret, J. M. and Benard, G. (1966) Contribution à l'étude de l'hérédité de la production de régimes d'*Elaeis guineensis* Jacq. *Oléagineux*, **21**, 657–661.

Gascon, J. P., Noiret, J. M. and Meunier, J. (1976) The IRHO programme. In: *Developments in crop science, 1. Oil palm research.* (eds. R. H. V. Corley, J. J. Harden and B. J. Wood), Amsterdam: Elseviers Scientific Publishing Co., 532 pp.

Hardon, J. J. (1970) Inbreeding in populations of the oil palm (*Elaeis guineensis* Jacq.) and its effect on selection. *Oléagineux*, **25**, 449–456.

Hardon, J. J. (1976) Oil palm breeding – introduction In: *Developments in crop science. 1. Oil palm research* (eds. R. H. V. Corley, J. J. Hardon and B. J. Wood), Amsterdam: Elseviers Scientific Publishing Co., 532 pp.

Hardon, J. J., Corley, R. H. V. and Ooi, S. C. (1972) Analysis of growth in the oil palm, 2. Estimation of genetic variances of growth parameters and yield of fruit bunches. *Euphytica* **21**, 257–264.

Hartley, C. W. S. (1977) *The oil palm* London: Longmans, 806 pp.

Jones, L. H. (1974) Propagation of clonal oil palms by tissue culture. *Oil Palm News*, (17), pp. 1–8.

Meunier, J., Gascon, J. P. and Noiret, J. M. (1970) Hérédité des caractéristiques du régime d' *Elaeis guineensis* Jacq. en Côte d' Ivoire. *Oléagineux*, **25**, 377–382.

Meunier, J. and Gascon, J. P. (1972) Le schéma général d' amélioration du palmier à huile à l' IRHO. *Oléagineux*, **27**., 1–12.

Meunier, J. and Hardon, J. J. (1976) Interspecific hybrids between *Elaeis guineensis* and *Elaeis oleifera.* In: *Developments in crop science. 1. Oil palm research* (eds. R. H. V. Corley, J. J. Hardon and B. J. Wood), Amsterdam: Elseviers Scientific Publishing Co., 532 pp.

Pronk, F. and Westenberg, M. G. (1955) AVROS circulars and unpublished report.

Sparnaaij, L. D. (1969) Oil palm (*Elaeis guineensis* Jacq.) In: *Outlines of perennial crop breeding in the tropics.* (eds. F. P. Ferwerda and F. Wit), *Miscellaneous papers of the Agricultural University of Wageningen*, **4**, 339–387.

Sparnaaij, L. D., Menendez, T. and Blaak, G. (1963) Breeding and inheritance in the oil palm (*Elaeis guineensis* Jacq.) part 1: The design of the breeding programme. *Journal of the West African Institute for Oil Palm Research*, **4**, 126–145.

Van der Vossen, H. A. M. (1974) Towards more efficient selection for oil yield in the oil palm (*Elaeis guineensis* Jacq.). *Agricultural Research Reports*, 823, Wageningen: PUDOC, 107 pp.

West, N. J. (1976) The analysis of the yield data of the NIFOR oil palm breeding programme and the choice of new parental material. A supplementary report to the Ministry of Overseas Development on Research Project R 2354. *Mimeo*, 41 pp.

West, M. J., Ross, J. M., Obasola, C. O. and Nekkako, H. U. (1976) The inheritance of yield and of fruit and bunch composition characters in the oil palm – an analysis of the NIFOR main breeding programme. *Malaysian International Agricultural Oil Palm Conference, 1976;* No. 8, pp 1–11.

GLYCOLIPIDS OF MALAYSIAN PALM OIL

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Summary

A study of the glycolipids of Malaysian palm oil shows the presence of esterified steryl glycosides, monoglycosyl diglycerides (MGDG), cerebrosides, steryl glycosides and diglycosyl diglycerides (DGDG), MGDG and DGDG being the major components. The amount of unsaturated fatty acids is found to be relatively high but palmitic acid (16:0), stearic acid (18:0), oleic acid (18:1) and linoleic acid (18:2) are the common fatty acids of all the glycolipids. In general, MGDG and DGDG have more unsaturated than saturated fatty acids whereas other glycolipids have more saturated fatty acids than unsaturated fatty acids.

Résumé

Une étude des glycolipides de l'huile de palme de Malaisie révèle la présence de stéryl glycosides estérifiés, de monoglycosyl diglycérides (MGDG), de cérébrosides, de stéryl glycosides et de diglycosyl diglycérides (DGDG), MGDG et DGDG étant les principaux constituants. On trouve une quantité relativement grande d'acides gras non saturés, mais l'acide palmitique (16:0), l'acide stéarique (18:0), l'acide oléique (18:1) et l'acide linoléique (18:2) sont les acides gras communs de tous les glycolipides. En règle générale, les MGDG et DGDG ont davantage d'acides non saturés que d'acides saturés alors que les acides gras saturés sont plus abondants que les acides gras non saturés dans les autres glycolipides.

Resumen

Un estudio realizado con los glicolípidos de aceite de palma malayo demuestra la presencia de glicósidos de esteril esterificados, diglicéridos monoglicosílicos (MGDG), cerebrósidos, glicósidos esterílicos y diglicéridos diglicosílicos (DGDG), siendo los principales componentes MGDG y DGDG. La cantidad de ácidos grasos sin saturar se encuentra que es relativamente elevada pero el ácido palmítico (16:0), el ácido esteárico (18:0), el ácido oleico (18:1), y el ácido linoleico (18:2) son los ácidos grasos más corrientes de todos los glicolípidos. En general, MGDG y DGDG tienen más ácidos grasos sin saturar que saturados, en tanto que en los otros glicolípidos, los ácidos grasos saturados predominan más que los sin saturar.

Introduction

Palm oil refers to the oil extracted from the mesocarp of the oil palm fruits. Commercial palm oil is mainly obtained by using physical extraction methods and the oil generally contains only a low level of glycolipids and phospholipids. The bulk of commercial palm oil is made up of triglyceride (Jacobsberg, 1974). While the chemistry of the neutral lipids of palm oil is well documented, the chemistry of the polar lipids in palm oil remains relatively unknown (Cornelius, 1977). In this communication the detailed chemical composition of glycolipids in palm oil is presented

Experimental

Fresh oil palm (*Elaeis guineensis*) fruits of the *dura* form were obtained from the Malaysian Agriculture and Development Institute (MARDI), Serdang, Selangor, Malaysia. The mesocarp of the fruits after separation from the shell was blended mechanically. The oil from the mesocarp was extracted by a modified method of Bligh and Dyer (Kates, 1972). The total lipids were stored in chloroform in the freezer (below 0°C) until use.

The total lipids were separated into neutral lipids, glycolipid and phospholipids on an acid-treated Florisil column (Carroll *et al.*, 1968). The glycolipids were further separated into their individual components by two-dimensional thin layer chromatography using chloroform: methanol: 28% ammonia (65:25:4, v/v/v) as the first solvent system, and chloroform: methanol: acetic acid: water (170:25:25:4, v/v/v/v) as the second solvent system. The nature of the glycolipids was identified by comparing the R_f values with that of commercial glycolipid standards (Supelco, USA) and with the use of specific staining reagents (Skipski and Barclay, 1969). The quantity of each glycolipid was estimated by assaying for the sugar moiety with phenol-sulphuric acid reagent (Dubois *et al.*, 1956). Preparative thin layer chromatography in the second solvent mentioned above was used to isolate pure glycolipids for fatty acid determination. Fatty acid methyl esters were prepared by the method of Hartman and Lago (1973), and analysed on a Varian Aerograph 1800 instrument equipped with a stainless steel column (2.44 m x 3.17 mm (8′ x 1/8″)) packed with 10% EGSS-X on Chromosorb W and operated isothermally at 180°C.

Results and discussion

Fractionation of the total lipids on an acid-treated Florisil column showed that 96.2%, 1.4% and 2.4% of the lipids are neutral lipids, glycolipids and phospholipids respectively. The higher percentage of polar lipids obtained in our study

ble 1
ycolipids of palm oil

ycolipids	R_f values x 100			Percentage of total	Fatty acids (percentage of total acids)						
	A*	B†	C‡		14:0	16:0	16:1	18:0	18:1	18:2	18:3
terified steryl glycosides	84	91	90	15.8	2	54	tr.	4	21	16	3
onoglycosyl diglycerides	74	80	85	26.8	tr.	9	tr.	2	30	18	40
erebrosides with hydroxyl fatty acids	69	69	64	5.6	tr.	28	–	3	38	27	2
eryl glycosides	63	62	57	4.9	3	50	–	25	18	4	–
erebrosides with normal fatty acids	61	56	46	7.3	9	46	–	11	22	12	–
glycosyl diglycerides	54	32	26	23.1	tr.	31	tr.	7	33	11	18
nidentified	–	–	–	16.5	–	–	–	–	–	–	–

Notes: * Solvent system A – Chloroform: methanol: water (65:25:4)
† Solvent system B – Chloroform: methanol: 28% ammonia (65:25:4)
‡ Solvent system C – Chloroform: methanol: acetic acid: water (85:15:10:3)
tr. trace, less than 1%

compared to that reported by Jacobsberg (1974) is robably due to different methods of extraction of the alm oil. In the present study we used a mixture of chloro- orm: methanol which would extract lipids, especially the olar lipids, more exhaustively than any other solvent ombination (Hubbard *et al.*, 1977).

he nature, quantity and fatty acid composition of the ycolipids are shown in Table 1. Results show that mono- ycosyl diglycerides (MGDG) and diglycosyl diglycerides DGDG) are the two major glycolipids in palm oil. MGDG nd DGDG were found by other investigators as major ycolipids in many other plant lipids. However, the con- nt of esterified steryl glycosides in palm oil is found to be igher than their content in other plant lipids (Kates, 1970).

nalysis of the fatty acid composition of the glycolipids hows that palmitic acid (16:0) is the major component in l the glycolipids except MGDG, which has a rather low ontent of this fatty acid. However, among the glycolipids, GDG has the highest content, about 40%, of linolenic cid (18:3). It may also be noted that in commercial palm il the content of linolenic acid is very low or sometimes ero (Clegg, 1973).

n general the level of unsaturated fatty acids is lower in alm oil than in the polar lipids because physical methods f extraction as done in commercial milling leave behind ubstantial amounts of the more polar lipids.

eferences

arroll, K. K., Cutts, J. H. and Murray, E. G. D. (1968) The lipids of *Listeria monocytogenes*. *Canadian Journal of Biochemistry*, **46**, 899–904.

legg, A. J. (1973) Composition and related nutritional and organoleptic aspects of palm oil. *Journal of the American Oil Chemists' Society*, **50**, 321–324.

ornelius, J. A. (1977) Palm oil and palm kernel oil. *Progress in the Chemistry of Fats and other Lipids*, **15**, 9–27.

Dubois, M., Giles, K. A., Hamilton, J. K., Rebers, P. A. and Smith, F. (1956) Colorimetric method for determination of sugars and related substances. *Analytical Chemistry*, **28**, 350–356.

Hartman, L. and Lago, R. C. A. (1973) Rapid preparation of fatty acid methyl esters from lipids. *Laboratory Practice*, **22**, 475–476.

Hubbard, W. D., Sheppard, A. J., Newkirk, D. R., Prosser, A. R. and Osgood, T. (1977) Comparison of various methods for the extraction of total lipids, fatty acids, cholesterol and other sterols from food products. *Journal of the American Oil Chemists' Society*, **54**, 81–83.

Jacobsberg, B. (1974) Palm oil characteristics. In: *Proceedings of the First MARDI Workshop on Oil Palm Technology, Kuala Lumpur, June 19–20*, pp. 48–70. Kuala Lumpur: MARDI.

Kates, M. (1970) Plant phospholipids and glycolipids *Advances in Lipid Research*, **8**, 225–265.

Kates, M. (1972) Techniques of lipidology. In: *Laboratory techniques in biochemistry and molecular biology, Vol. 3, Part 2* (eds. T. S. Work and E. Work), pp. 275–610. Amsterdam: North Holland Publishing Co., 341 pp.

Skipski, V. P. and Barclay, M. (1969) Thin-layer chromatography of lipids. In: *Methods in enzymology, Vol. 14 Lipids* (ed. J. M. Lowenstein), pp. 531–598. New York and London: Academic Press, 771 pp.

A report by the Marketing and Industrial Economics Department, Tropical Products Institute

Revised global production data for palm oil indicate that in 1978 slightly in excess of 4 million tonnes were produced, (Table 1). On average, production between 1975 and 1978 grew at around 7% per annum with some slowdown between 1977 and 1978. However, provisional data for 1979 suggest that a substantial increase is again in prospect. Production figures for Malaysia (both East and West) and Indonesia show substantial growth in 1979 (in the region of 20% above levels for 1978), and global production levels are approximately 12% above those achieved in 1978.

Palm oil production in other producing countries, notably in West Africa and China, has generally been stagnant and/or subject to rather erratic fluctuations and as such these countries have made little contribution to recent expansion.

Provisional data for palm oil exports in 1979 show a global total of over 2.3 million tonnes, (Table 2), in comparison to the 1978 export figure of under 2.1 million tonnes. Increased exports are the result of a sharp increase in Malaysian shipments which have offset generally weak or declining exports from other countries (with the exception of Papua New Guinea). The long-term expansion in Malaysian exports is reflected by a rising share of the global total from around 57% in 1975 to 73% in 1979.

Increasing Malaysian exports stem from expanded production, but over the period 1975–79 production growth has generally exceeded that of exports (and domestic consumption). The composition of Malaysian exports has continued to shift rapidly towards refined palm oil derivatives with only around 12% of the 1979 export total represented by crude palm oil. (The comparable figure for 1978 was a little under 40%).

Exports from Indonesia, the second largest exporter, stagnated between 1976 and 1978 and declined in 1979, despite expanding production. Restricted Indonesian exports have arisen as a result of rapidly expanding domestic consumption, in part directed towards the substitution of coconut oil in order to enable the resumption of exports of the latter commodity. Rising domestic consumption (together with stagnating production in many instances), also explains the poor performance of other exporters over the period 1975–79 and in particular the virtual disappearance of export availability in a number of West African countries.

With regard to import markets, interest continues to centre upon the relative shares of four major importing countries/country groupings: the European Community (EC), the United States of America (USA); major Centrally Planned Countries, and a small selection of developing and Organisation of Petroleum Exporting Countries (OPEC) countries. Commencing in 1977 a dramatic shift in export trade has occurred towards developing countries, (Table 3).

Table 1
World production of palm kernels and palm oil

'000 tonnes

	1975		1976		1977		1978		1979‡	
	Kernels	Palm oil	Kernels	Palm oil	Kernels	Palm oil	Kernels	Palm oil	Kernels	Palm oi
West Malaysia	233	1,137	246	1,261	305	1,484	312	1,640	n.a.	2,032
Nigeria	295	640	295	655	302	660	345	670	n.a.	675
Indonesia	82	397	82	434	92	496	98	514	n.a.	604
Zaire	75	165	74	178	72	175	72	175	n.a.	136
China,	38	150	40	160	42	162	44	163	n.a.	162
East Malaysia*	21	121	55	128	30	124	52	144	n.a.	155
Ivory Coast	36	154	36	144	32	118	38	151	n.a.	120
Cameroon	45	60	45	80	47	82	49	84	n.a.	90
Sierra Leone	52	55	44	44	46	46	30	45	n.a.	45
Benin	73	22	80	25	80	28	70	27	n.a.	35
Others †	171	362	207	386	201	454	201	401	n.a.	446
World total †	1,121	3,263	1,204	3,495	1,249	3,829	1,311	4,014	n.a.	4,500

Sources: *Oil World*
FAO Production Yearbook
FAO Monthly Bulletin of Agricultural Economics and Statistics

Notes: * East Malaysia = Sabah and Sarawak
† totals exclude Brazilian production since the latte includes babassu and other kernels
‡ data for 1979 are provisional
n.a. = not available

Table 2
Exports of palm kernels and oil and net exports of palm oil

'000 tonnes

	1975		1976		1977		1978		1979†	
	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil
Palm kernels and oil										
West Malaysia	–	109	–	124	‡	105	‡	130	–	192
Nigeria	171	26	272	13	182	15	103	39	65	51
Zaire	–	29	–	23	–	15	–	17	–	16
Sierra Leone	29	10	18	10	5	8	2	9	13	7
Indonesia	32	25	25	21	25	20	7	11	24	1
Ivory Coast	29	‡	29	–	17	–	4	14	4	9
Benin	–	12	–	14	–	10	–	3	–	10
East Malaysia*	25	–	25	–	17	–	22	–	20	–
Cameroon	12	–	12	–	10	–	7	–	10	–
Guinea Bissau	4	–	9	–	6	–	11	–	8	–
Guinea Republic	9	–	7	–	11	–	5	–	7	–
Others	22	12	17	21	19	12	21	7	24	21
World total	333	223	414	226	292	185	182	230	175	307
Palm oil										
West Malaysia		1,032		1,207		1,304		1,365		1,715
Indonesia		386		406		405		412		350
East Malaysia*		128		128		124		144		155
Ivory Coast		114		92		79		75		55
Papua New Guinea		24		27		25		28		40
Others		130		65		47		42		35
World total		1,814		1,926		1,984		2,066		2,350

Sources: *Oil World*
FAO Trade Yearbook
FAO Monthly Bulletin of Agricultural Economics and Statistics

Notes: * East Malaysia = Sabah and Sarawak
† data for 1979 are provisional
‡ negligible

Imports by EC countries have been erratic over the period 1975–79 but exhibit little change when the beginning and end years are compared. However, in the USA a sharp decline in imports is apparent from 1976 to 1978, stabilising in 1979. The declining imports into the USA and overall stagnation in EC countries stems particularly from relative soyabean oil: palm oil prices, with palm oil commanding a premium in USA markets from 1977 onwards. Weak price performance against other oils, e.g. rapeseed oil and fish oil, has also limited import demand.

Stagnating and/or declining imports into the developed countries has been more than offset by dramatically enlarged imports into India in particular since 1977, together with a smaller, but nonetheless significant expansion in imports by Pakistan, Iraq and Saudi Arabia. The two major Centrally Planned Countries, China and the Soviet Union, have also increased imports since 1977.

Recent movements in palm oil prices (Table 4), show a sharp up-turn commencing in the first quarter of 1979, with only a gradual decline thereafter. The rise in prices during the first quarter of 1979 stemmed from general commodity market uncertainties as a result of developments in Iran and also Vietnam and China. A similar feature is also apparent for the first quarter of 1980, again stemming from general market uncertainties with regard to Iran and the continuing upsurge in petroleum oil prices, together with events in Afghanistan.

In the latter part of 1979, palm oil prices fell away as a result of excess availability and rising stock levels (Table 5), and a similar trend is evident for 1980. Despite the current fall in palm oil prices, import demand has been limited by relatively large stock holdings in a number of important importing countries, together also with large domestic supplies of fats and oils generally. In importing countries overall, surpluses/high stock levels of fats and oils, falling prices, high interest rates, foreign exchange problems and the overall economic recession have inhibited potential import demand. Thus a further substantial fall in palm oil prices will probably be needed in order to improve its performance against other major oils (soyabean oil, rapeseed oil, sunflowerseed oil etc.), and hence to raise import demand.

Palm kernel production data for 1979 are as yet unavailable, but for the period 1975–78 global production expanded fairly steadily at around 5.4% per annum to reach 1.3 million tonnes (Table 1). Major contributors to expanded output have been Malaysia and, in 1978, Nigeria. Whilst Nigerian palm oil production has not exhibited any substantial expansion, greater palm kernel production may be attributed to more effective collection (including wild palm

Table 3
Net imports of palm kernels and oil and palm oil

'000 tonne

	1975		1976		1977		1978		1979*	
	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil	Kernels	Oil
Palm kernels and oil										
European Community	243	120	305	108	250	99	139	133	129	164
of which:										
United Kingdom	75	63	87	65	56	60	43	62	68	60
Netherlands	98	11	137	3	85	21	53	38	33	49
Germany, Fed. Rep. of	42	35	50	11	72	–5	15	11	5	25
France	13	21	9	15	12	16	8	15	9	16
Other West Europe	14	5	23	10	20	12	13	11	5	13
USA	–	72	–	68	–	67	–	58	–	79
Japan	7	5	7	3	11	4	6	7	9	10
Others	33	36	21	23	26	28	19	28	18	36
World total	297	238	356	212	307	210	177	237	161	302
Palm oil										
European Community		658		702		657		625		695
of which:										
United Kingdom		206		242		228		218		228
Germany, Fed. Rep. of		190		173		179		151		160
Netherlands		129		121		109		92		110
Italy		51		59		33		57		71
France		49		63		66		65		68
Belgium/Luxembourg		27		24		25		24		34
Other West Europe		51		59		60		62		65
USA		427		340		220		136		138
Japan		108		154		147		142		139
India		51		22		300		485		401
Pakistan		151		114		155		134		203
Iraq		109		106		101		123		140
Saudi Arabia		–		11		43		56		80
Soviet Union		–		10		47		48		107
China		8		–		25		11		42
Others		192		279		281		258		320
World total		1,755		1,797		2,036		2,080		2,330

Sources: *Oil World*
FAO Trade Yearbook
FAO Monthly Bulletin of Agricultural Economics and Statistics

Note: * 1979 data are provisiona

material), in response to rising international prices. However, the data for Nigeria could be suspect particularly in view of the poor export performance indicated in Table 2. Indonesia has also raised palm kernel production, but other countries generally exhibit only modest expansion and/or stagnating production trends.

Despite increasing levels of production, exports of palm kernels and palm kernel oil have been variable (Table 2), reaching a low point in 1977 and subsequently recovering in 1979 to levels similar to those in 1975 (in oil equivalents converted at 47% oil content).

The major contributor to growing export volumes (of palm kernel oil), has been Malaysia, which has offset the recent decline in Nigerian exports and generally weak performances amongst minor exporting countries. Nigerian exports have increasingly taken the form of palm kernel oil, which together with a similar trend in a number of minor exporting countries has resulted in a pronounced shift towards oil rather than kernel exports. By 1979 palm kernel expo formed only around 21% (in oil equivalent) of the global total, in comparison to 41% in 1975.

Global imports of palm kernels and palm kernel oil contin to be dominated by EC countries together with the USA (Table 3), the latter country importing only oil. In line w declining export availability, EC imports show a strong movement towards palm kernel oil over the period 1975–79, together with a recovery in import volumes after a lo point in 1977. Imports into the USA have also recovered strongly in 1979.

Prospects for palm kernel oil are closely linked with coco nut oil for which it acts as a substitute in many end-use markets. Coconut oil acts as the price leader and as such palm kernel and palm kernel oil prices have followed the upsurge in prices for coconut oil which occurred in the

latter part of 1978 and during 1979 (Table 4). The apparent paradox of increasing volumes of palm kernel and palm kernel oil imports (in oil equivalent) in the context of rising palm kernel and palm kernel oil prices is explained by the even more acute shortage of coconut oil and hence raised demand for substitutes. Whilst palm kernel and palm kernel oil prices have risen broadly in line with those for coconut oil, the increase has not been so sharp and relative prices have moved from a premium to a discount for palm kernel oil: coconut oil from 1978 to 1979.

During the current period (the first half of 1980), increasing coconut oil availability and restricted import demand (stemming partly from economic recession in major importing countries), has led to falling coconut oil prices, a feature closely mirrored by those for palm kernel oil. Given an expanding export availability for palm kernels and palm kernel oil overall, further falls in price may be expected.

Table 4
Prices of palm kernels and oil and palm oil: quarterly and annual averages

US $ per tonne

		Palm kernels Nigerian dealer c.i.f. Europe	Palm kernel oil Malaysian c.i.f. UK	Palm oil Malaysian/ Sumatran (resale) c.i.f. continent
1975	I	249	492	450
	II	184	502	385
	III	191	495	420
	IV	200	479	421
	Annual	207	492	416
1976	I	158	–	387
	II	201	–	372
	III	260	–	446
	IV	291	523	456
	Annual	228	523	415
1977	I	333	610	524
	II	405	769	643
	III	279	448	506
	IV	273	507	498
	Annual	323	637	543
1978	I	320	608	561
	II	357	654	647
	III	366	700	640
	IV	421	835	631
	Annual	366	699	620
1979	I	492	947	695
	II	537	1,057	689
	III	524	1,047	670
	IV	437	902	623
	Annual	498	988	669
1980	I	406	811	665
	II*	327	639	602

Source: *The Public Ledger* **Note:** * April and May only

Table 5
Stocks* of palm kernel oil and palm oil (at January 1st)

'000 tonnes

	1975	1976	1977	1978	1979	1980
Palm kernel oil	74	69	72	80	72	85
Palm oil	292	366	380	424	595	759
of which:						
West Malaysia	98	140	126	171	308	420
European Community†	54	74	148	70	61	94
India	4	4	5	50	80	90
USA	47	74	85	40	28	37

Source: *Oil World*

Notes: * visible stocks as declared by major trading countries
† including Dutch bonded warehouses

LA FUSARIOSE VASCULAIRE DE L'*ELAEIS GUINEENSIS* JACQ. A–B. Ergo. Centre d'Informatique appliquée au Développement et à L'Agriculture Tropicale (CIDAT). Musée Royal de L'Afrique Centrale: Tervuren, Belgium, 1978 (in French): 229 pp., 9 figures, 44 tables, bibliography 200 refs.

Oil palm is a major economic crop of the Guinea region of Africa and there is a growing interest in the effect of diseases on oil palm production. One of the more important diseases of the palm is Fusarium wilt (Fusariose) caused by a specific strain of *Fusarium oxysporum* designated *F. oxysporum* f. sp. *elaeidis* Toovey.

This book summarises the major investigations carried out on the disease and the present disease situation, its origin and economic importance.

The information is systematically dealt with from the pathogens origin, to its occurrence in the rhizosphere, its survival in soil and methods of infection. The disease symptoms on the host both external and internal are described and various methods of control are given. The latter include methods of cultivation, genetical selection and chemical treatments. Methods of isolation and testing for pathogeneity and the setting up of controlled experiments is discussed. Finally the effect of the environment in different parts of tropical Africa is analysed, a bibliography of 200 references and brief summaries in French, English and Dutch are given. This publication forms a useful source book for those involved with the disease.

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THE PALM OIL INDUSTRY IN WEST MALAYSIA

Lanagan, K. J., (Oilseeds and Products Division, Foreign Commodity Analysis, Foreign Agricultural Service), *US Department of Agriculture, FAS M–276,* 1977, 25pp.

The author provides information on the state of the palm oil industry in Peninsular Malaysia with particular reference to its expansion since 1965. Oil palm production areas are detailed by State and compared with rubber with special reference to FELDA estates. Production methods are reviewed with regard to pre- and post-harvest aspects. The report includes a description of refining, bulking and shipping methods and facilities, trade and government policy, determinants of yield and production projections to 1990. Breeding is discussed and other export crop options considered. Production costs for oil palm and rubber are compared and profitability relationships and implications for diversification discussed.

OIL PALM PROJECTS

Anon., *Standard and Chartered Review,* August 1979, p.35.

The World Bank and the Ghana Government have pledged to invest a total of US$22.5 m in the newly formed Oil Palm Development Corporation with the Bank providing $13.6 m and Ghana making available the balance of $8.9 m.

The Corporation is to develop 25,000 acres (10,000 ha) of oil palm plantation at Kwae near Kade in the Eastern Region to produce industrial palm oil for soap manufacture.

The first phase, which is to be completed in 1981, involves the establishment of a 10,000-acre (4,000 ha) nucleus plantation, a 3,000-acre out-growers' scheme and the construction of a palm oil mill.

A loan of £1.75 m made by the European Community to the State Farms Corporation is for the rehabilitation and extension of the Prestea Oil Mills at Asraku in the Western Region. Feasibility studies for the rehabilitation project have already been completed and three experts from Brussels will be arriving shortly to assist local contractors. When the rehabilitation and extension works are completed, the Prestea Oil Mills will double its present annual production. The mills currently harvest in the region of 20,000 tonnes of fresh fruit annually from an 11,000-acre plantation.

AMAZONIAN OIL PALMS OF PROMISE: A SURVEY

Balick, M. J. (Botanical Museum of Harvard University, Cambridge, Massachusetts 02138, USA), *Economic Botany,* 1979, **33**, 11–28.

This paper presents a literature search offering a general background on palms with a high content of oil in their fruits. Most of the 25 species discussed are Amazonian. Since many species of palms are potentially valuable for commercial oil extraction, general information is included. The notes are intended to encourage projects for commercial exploitation now under way with sundry species. Palms of the following genera are discussed: *Acrocomia* Martius, *Arecastrum* Beccari, *Astrocaryum* Meyer, *Bactris* Jacquin, *Butia* Beccari, *Elaeis* Jacquin, *Jessenia* Karsten, *Manicaria* Gaertner, *Mauritia* Linn. fil., *Oenocarpus* Martius, *Orbignya* Mart. ex Endl., *Scheelea* Karst. and *Syagrus* Martius.

CONCERNING FOUR WILD PALMS OF LATIN AMERICA (À propos de quatre palmiers spontané d'Amérique latine)

Martin, G. and Guichard, P. H. (IRHO, 11 Square Pétrarque Paris 16e, France), *Oléagineux,* 1979, **34**, 375–384.

(In French and Spanish. English summary, 13 lines)

Alongside the high-yielding oil crops currently grown, there exists a certain natural plant wealth, often ill-known and difficult of access, but with a yield potential which appears considerable. In Latin America, there are 4 types of wild palm presenting varying degrees of interest. These are: *Oenocarpus, Acrocomia, Orbignya* and *Mauritia,* which produce either liquid pulp oils of fluid character comparabl to olive oil, or solid kernel oils like those of oil palm or coconut. Much research remains to be done before the existing population and biology of these plants are well-known, but in spite of the present difficulties involved in their exploitation, the part they could play in the development of the region in which they grow must not be overlooked.

THE 50TH INTERNATIONAL CONGRESS ON AGRICULTURAL MACHINERY: INFORMATION FOR PLANTERS OF OIL PALM AND COCONUT
(Le 50e salon international du machinisme agricole: informations pour les planteurs de palmiers à huile et de cocotiers)

Martin, G. (IRHO, 11 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1979, **34**, 353–358.

(In French)

After a survey of the Congress the article provides information on equipment used in the culture of perennial oleaginous crops comprising traction, earth preparation and maintenance (mechanical and chemical weeding), followed by equipment which may be used to harvest tall palms. The final sections deal with equipment for phytosanitary treatment and vehicles for travelling around estates.

METHOD OF ESTIMATING THE TIME REQUIRED FOR LAND CLEARING AND MECHANICAL WINDROWING OF AN INDUSTRIAL OIL PALM PLANTATION
(Méthode d'estimation des temps de travaux pour le défrichement et l'andainage mécanique d'une palmeraie industrielle)

Martin, G. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1976, **31**, 59–62.

(In French, English and Spanish)

The method of estimation of work time and expenses set out in this advice note 158 is simply intended to be a first approach to this problem in the case of the use of a standard caterpillar machine.

The studies undertaken for more than 15 years for the planting of large industrial oil palm units have made it possible to define the technique which corresponds best to the objectives pursued and to evaluate the average time necessary for the various operations and the incidence of factors which affect the output of the material. In particular, they have shown the care that must be taken in the choice of method, equipment and material. At present, and provided all necessary precautions are taken, it can be affirmed that mechanical deforestation is the only suitable method for large annual planting programmes.

METHODS OF CULTIVATING OIL PALM AND COCONUT IN NUTRIENT SOLUTIONS
(Technique de culture en solutions nutritives du palmier à huile et du cocotier)

Dufour, F., Quencez, P. and Schmitt, G. (IRHO Experimental Station, La Mé Station, Ivory Coast), *Oléagineux,* 1978, **33**, 485–490.

(In French and English. Spanish summary, 5 lines)

For the better understanding of certain mineral nutrition mechanisms, it is sometimes necessary to resort to pot culture on nutrient solutions. The authors describe the technique worked out in the IRHO station at La Mé for oil palm and coconut.

GROWING AND EXPLOITATION OF MALAYAN BAMBOO FOR PRODUCTION OF HARVESTING POLES
(Culture et exploitation du bambou malais en vue de la production de perches de récolte)

Faivre, Y. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1979, **34**, 517–522.

(In French, English and Spanish)

This advice note describes the techniques for multiplying and preparing Malayan bamboo for the production of oil palm harvesting poles. (IRHO advice note 198).

Breeding

GERMINATION OF OIL PALM SEEDS (*E. GUINEENSIS*) IN POLYTHENE BAGS
'DRY HEAT' METHOD

(Germination des graines de palmier á huile (*E. guineensis*) en sacs de polyéthyléne. 'Méthode par chaleur séche')

Comont, G. and Jacquemard, J. C. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1977, **32**, 95–99.

(In French, English and Spanish)

This note No. 171 on agricultural practice describes a metho of germination of oil palm seeds which has the advantage of requiring the minimum of observations and manipulations whilst enabling germinations to be grouped in 3–4 weeks.

The first stage of the method involves placing the seeds in a germinator and raising their dormancy by heating at betwee 17 and 19% humidity on fresh kernel weight. No germination should take place during this period. The second stage–germination itself – is achieved by placing the heavily re-moistened seeds at ambient temperature at a moisture content of 23–25% on fresh weight.

A formula is given for calculating the moisture content of fresh kernels at either stage. If 'H' represents the moisture content, 'A1' the weight of a sample of 20 roughly-crushed kernels and 'A2' the weight of the same sample oven-dried at 105°C, then $H = \frac{A1 - A2}{A1}$ per 100.

For the second stage of germination, a detailed description is given of the various steps to be taken, starting with the

oaking of the seeds for 7 days in water at ambient tempera-ure (±25°C) changed every 24 hours and afterwards drying ntil the seeds take on a very dark grey colour (a sign that he moisture content is about 19 per cent). Seeds of the ame type of cross and having spent a comparable length f time in storage should then be placed in transparent, ermetically-sealed polythene bags and heated in a germin-tor for 80 days.

fterwards the seeds should be re-hydrated by soaking for days in water at ambient temperature renewed every 4 hours. Slight drying until the seeds turn from shiny to ull black should bring kernel moisture to 23–25 per cent. he seeds are then returned to hermetically sealed bags and ept either in the shade at a temperature of 25–27°C or, if ecessary, in a temperature-controlled room. Weekly sorting required to select those ready for despatch.

hen the operator has no germinator he can request pre-eated seeds which have already been soaked for 7 days and eated at 38–40°C for 80 days in a germinator. The planter ust then carry out the subsequent operations described bove.

ELECTION AMONG *PISIFERA* FOR PRODUCTION OF *ENERA* IN THE OIL PALM (*E. GUINEENSIS*, JACQ.). CATEGORIES OF *PISIFERA*

basola, C. O. and Okwuagwu, Mrs. C. O. (Plant Breeders, IFOR, Near Benin City, Nigeria), *Journal of the igerian Institute for Oil Palm Research,* 1978, **5**, 101–107.

lthough it has been reported that the quality of the *tenera* btained from *dura* x *pisifera* crosses can be influenced by ne pollen parent used, this aspect has not been critically udied. In this paper, an attempt has been made to categor-e the *pisifera* more critically in order to be able to design a roper trial to test the relationship between fertility of the *isifera* and additive component of shell thickness in *dura* x *isifera* crosses of the oil palm.

lid-longitudinal sections of fruits produced by normally uit-bearing *pisifera* palms were examined. Four types of uits were obtained, viz.: fruits with endosperm and mbryo, fruits with endosperm but no embryo, fruits with either endosperm nor embryo, and under-developed fruits.

he proportions of each of the types of fruits obtained xplained the poor germination of the seeds from *pisifera* alms. No definite relationship exists between the fertility f a palm and the origin of the parent palm, although the alms of Angolan origin appear to have a high proportion f fertile fruits.

hen the bunches were treated with α–(2,4,5) – trichloro henoxy propionic acid, fleshy oil bearing parthenocarpic uits were produced from flowers which could have become nder-developed fruits in natural conditions. On the basis f regularity of yield and type of fruits obtained from the *pisifera* palms treated with α–(2,4,5,) – TP, eight categories of palm could be identified. The implication of these categories of *pisifera* on selection for seed production is discussed.

PROGRESS WITH VEGETATIVE PROPAGATION OF OIL PALM

Corley, R. H. V., Wooi, K. C. and Wong, C. Y. (Clonal Oil Palm Research Unit, Unipamol Malaysia Sdn. Bhd, Layang-Layang, Johor, Malaysia), *Planter, Kuala Lumpur,* 1979, **55**, 377–380.

In 1974 Jones reported (*Oil Palm News,* 1974, (17), pp. 1–8) early results of work on propagation of oil palm by tissue culture carried out in the Unilever Research Laboratory, Colworth House, Bedford, United Kingdom. Clonal plants produced in that programme were brought to Malaysia, and their behaviour in the nursery has been described (*Oil Palm News,* 1977, (22), pp. 2–7). Since these early reports, the authors have made considerable progress in development of the tissue culture propagation technique. The first field trials have been planted and the first bunches have been harvested from a few palms. A tissue culture laboratory has been set up in Malaysia and an extensive programme of culturing from selected mature palms has commenced.

There can now be little doubt that clonal oil palm planting material will become commercially available during the next decade. Clonal palms produced by tissue culture are already growing in the field, fruiting normally and producing viable seeds and pollen. Variability within the clones is appreciably less than within seedling progenies. The authors have also shown that the tissue culture technique, originally developed with seedling material, can be successfully applied to propagate selected mature palms. The only remaining step, before commercial quantities of planting material can be released, is field testing of the selected clones to confirm their superiority to seedling planting material.

PALM OIL COMPOSITION AND OIL PALM BREEDING

Corley, R. H. V. (Clonal Oil Palm Research Unit, Unipamol Malaysia Sdn. Bhd, Layang-Layang, Johor, Malaysia), *Planter, Kuala Lumpur,* 1979, **55**, 467–478.

A change in the proportion of unsaturated fatty acids and other modifications of palm oil composition might be obtained by selective breeding, although the process would take some generations. Hybrid palms could give a bigger faster change. In both cases some sacrifice of yield might be necessary initially. Tissue culture could make these changes possible in the more immediate future. Market requirements must, however, be kept in mind.

A PRELIMINARY ASSESSMENT OF THE INFLUENCE OF AGE AND THE TIME OF TRANSPLANTING ON THE PERFORMANCE OF POLYBAG SEEDLINGS IN THE FIELD

Aya, F. O. (Agronomist, NIFOR, Near Benin City, Nigeria), *Journal of the Nigerian Institute for Oil Palm Research,* 1978, **5**, 7–14.

In an attempt to determine the influence of age and the time of transplanting on the performance of polybag seedlings in the field, 9–13-month old polybag seedlings were transplanted into the field at the main station of the Nigerian Institute for Oil Palm Research from April to September, 1974. Results obtained during the first 18 months of the experiment showed that the time of transplanting influenced the field vigour and the onset of female flower production of the polybag seedlings to a greater extent than seedling age.

It is concluded from this experiment that the best time to transplant polybag seedlings into the field in the Benin area of Nigeria is April–June and that such seedlings should preferably be 10–12 months old.

THE USE OF POLYETHYLENE BAGS FOR RAISING OIL PALM SEEDLINGS IN NIGERIA. II – THE INFLUENCE OF BAG SIZE, COLOUR, DRAINAGE AND PLANTING DATE ON THE PERFORMANCE OF THE SEEDLINGS IN THE NURSERY

Aya, F. O. (Agronomist, NIFOR, Near Benin City, Nigeria), *Journal of the Nigerian Institute for Oil Palm Research,* 1978, **5**, 15–20.

Experiments at NIFOR investigating the influence of bag size, colour, drainage and planting date on the performance of oil palm seedlings in polybag nurseries showed that all the factors had varying effects on seedling vigour. Bags higher than 35.6 cm or wider than 40.6 cm had no added advantage in terms of seedling growth. Bag colour showed significant effects on seedling heights, leaf production and number of transplantable seedlings. There were 92.7% torn colourless bags compared with 12.1% black bags within 6 months in the nursery. Planting dates had significant effects on mean heights, incidence of blast and the number of transplantable seedlings, while drainage had no apparent influence on the various parameters under the sandy soil conditions of the experiments.

NITROGEN IN PRECIPITATION AT THREE LOCATIONS IN THE OIL PALM BELT OF NIGERIA

Ataga, D. O. (Soil Chemist, NIFOR) and Nnabuchi, S.E. (Principal Agricultural Superintendent (Statistics), NIFOR, Near Benin City, Nigera), *Journal of the Nigerian Institute for Oil Palm Research,* 1978, **5**, 21–24.

The average amount of nitrogen in rainfall at NIFOR, Ben City (Main Station), Abak and Acharu experimental stati in 1974 and 1975 were 7.21, 6.68 and 5.65 kg/ha per ann respectively. The amount of nitrogen in rainfall on the M Station was shown to be about 25% of nitrogen removed annually through palm bunches. This contribution to the nitrogen economy of the soil is considered to be of specia significance in mature oil palm plantations where the ecological conditions are fairly stable.

SOIL PHOSPHORUS STATUS AND RESPONSES OF TH OIL PALM TO PHOSPHORUS ON SOME ACID SOILS

Ataga, D. O. (Soil Chemist, NIFOR, Near Benin City, Nigeria), *Journal of the Nigerian Institute for Oil Palm Research,* 1978, **5**, 25–36.

The phosphorus status of some soils in relation to the response of the oil palm to phosphorus fertilization was assessed by five soil test methods, namely, equilibrium phosphate potential, Bray and Kurtz's (0.03N NH_4F in 0.025N HCl), Morgan's (10% CH_3COONa/3% CH_3COOH) Sounder's (0.1N NaOH) and Olsen's (0.5N $NaHCO_3$ at pH 8.5) using absolute yield response, relative yield and uptake of phosphorus as response criteria in the greenhous and relative bunch yield in the field.

Absolute yield response, relative yield and phosphorus uptak obtained from the greenhouse study correlated well with soil test for all methods. Relative bunch yield was also fai well correlated with the soil tests. Irrespective of plant response criterion used, the equilibrium phosphate metho is as good as, or slightly better than, the Bray and Kurtz's method but superior to the Morgan's, Saunder's and Olsen methods.

From the relationship between Bray and Kurtz's soil test value of P and relative oil palm bunch yield, a tentative grouping of these soils into three phosphorus response are was proposed as follows:

(1) Soils in which phosphorus level is very low and considerable response to phosphorus fertilization will be obtained (Bray and Kurtz's $P < 5$p.p.m.);

(2) Soils in which phosphorus level is moderate and medi to little response to phosphorus will be obtained (Bra and Kurtz's P, 5–10 p.p.m.);

(3) Soils in which phosphorus levels are relatively high and little or no response to phosphorus fertilizer will be likely (Bray and Kurtz's $P > 10$ p.p.m.).

Abbreviation: p.p.m. = parts per million

PHOSPHATE SORPTION CHARACTERISTICS AND THE USE OF SORPTION ISOTHERMS FOR EVALUATING THE PHOSPHATE REQUIREMENTS OF THE OIL PALM ON SOME ACID SOILS

Ataga D.O. and Omoti, U. (Soil Chemists, NIFOR, Near Benin City, Nigeria), *Journal of the Nigerian Institute for Oil Palm Research,* 1978, **5**, 37–47.

Phosphorus absorption studies were carried out on some soils supporting the oil palm. All the soils adsorbed from little to moderately large amounts of phosphate. The phosphorus absorption maxima as determined from linear plots of Langmuir adsorption equation ranged from 35.5–387 p.p.m. P, the soils derived from Basement Complex Rocks having higher adsorption maxima than the acid sand soils. P adsorption was significantly correlated with Al and Fe sesquioxides, exchangeable Al as well as clay content. The Al and Fe sesquioxides both account for 68.0% of the variation observed in phosphate sorption.

Phosphorus requirements of the oil palm in the soils estimated from P adsorption isotherms at 0.2 p.p.m. supernatant P concentration ranged from 0.689 to 15.86 kg superphosphate per palm and were significantly correlated with the relative yield data obtained both from greenhouse and field experiments. The indication therefore is that the values obtained approximate, or are closely related to, the true phosphorus requirements of the oil palm in these soils.

INFLORESCENCE AND BUNCH ABNORMALITIES IN THE OIL PLAM (*ELAEIS GUINEENSIS,* JACQ.)

Obasola, C. O., Menendez, T. and Obisesan, I. O., *Journal of the Nigerian Institute for Oil Palm Research,* 1978, **5**, 49–57.

Observations on abnormal inflorescences in the oil palm identified at NIFOR are presented. The majority of the abnormalities discussed in this paper had spontaneous origin. A few were artifically induced by using (2, 4, 5,-trichlorophenoxy) propionic acid. The following types of abnormalities were encountered: hermaphroditic, andromorphic and andromorphic-hermaphroditic inflorescences. Others are hermaphroditic florets, deformed bunches, bunches with poor fruit set, twin bunches from a single leaf axil, bunches with several bunchlets and inflorescences with mantled fruits surrounded by fruit-bearing male fingers. Production of andromorphic hermaphroditic bunches is very common in *Elaeis guineensis* x *E. oleifera* hybrids and crosses between these hybrids and *E. guineensis.* Hermaphroditic florets can complicate oil palm breeding procedures as these tiny florets can lead to self fertilization instead of a planned cross. Furthermore, such trees are usually unfit for seed production although they may possess desirable characteristics.

CHANGES IN AMINO ACIDS DURING BREAKING OF DORMANCY IN OIL PALM SEED

Odetola, J. A. (NIFOR), Kozlowski, T. T. (Department of Forestry, University of Wisconsin, Maddison, Wisconsin, USA) and Vojtik, F. (Department of Plant Pathology, University of Wisconsin), *Journal of the Nigerian Institute for Oil Palm Research,* 1978, **5**, 59–65.

Changes in free amino acids during heat-induced breaking of dormancy of three sources of oil palm seed were studied. Both the kinds of amino acids and their amounts varied appreciably among seed sources. In both dormant and non-dormant seeds of all sources the amounts of individual amino acids in the embryo exceeded those in the endosperm. During release from dormancy the amounts of various amino acids increased in both the embryo and endosperm. In the embryo the greatest increases were in alanine, arginine, glutamic acid, lysine, serine and tyrosine. In the endosperm the increases during dormancy release were greatest in alanine, glutamic acid, proline, serine and valine. The possible significance of changes in amino acids during release from dormancy of oil palm seed is discussed.

THE OPTIMUM SPACING FOR OIL PALMS IN NIGERIA

Maliphant, G. K., *Journal of Nigerian Institute for Oil Palm Research,* 1978, **5**, 67–78.

Data from a spacing trial at the Main Station, Nigerian Institute for Oil Palm Research, Benin City, Nigeria are presented. Previous workers published the results of the same trial for 1950–1961 and the present paper extends the study to 1972 when the palms were 27 years old. The highest annual yield of bunches per hectare would have been obtained from densities of 149 and 71 palms/ha for triangular and wide-spaced rows (19.8 m) respectively. The optimum densities for number of bunches per hectare were 167 and 94 palms/ha respectively. Optimum densities for cumulative yields were 171 palms/ha for triangular spacing, 77 palms/ha for wide-spaced rows (19.8 m) and 187 palms/ha for close-spacing with rows (6.4 m). The cumulative yields over 23 years were 246,700, 131,600 and 222,300 kg/ha, respectively. Highly significant negative correlations were shown between mean single bunch weights and planting density. Yields were significantly related to number of bunches/ha and dry season (November–March) rainfall three years earlier. Number of bunches/ha were significantly correlated with the age of the palms and dry season (November–March) rainfall two years earlier. Progenies of differing origin showed significantly different optimum planting densities.

OIL PALM PLANTING DENSITY AND THINNING OF MATURE PLANTINGS

Corley, R. H. V. (Clonal Oil Palm Research Unit, Unipamol Malaysia Sdn. Bhd., Layang-Layang, Johore, Malaysia), *Planter, Kuala Lumpur,* 1977, **53**, 349–359.

The optimal planting density for oil palms is defined as that density which will give the greatest discounted cash flow over a given period. It is shown that this density is always higher than the density giving greatest yield from palms more than 10 years old and that in consequence a yield decline is to be expected, before this age, in a planting at the optimal density.

Symptoms of over-dense planting, and the possibility of thinning, are discussed, and it is shown that thinning is unlikely to be profitable in most circumstances in South East Asian countries.

DEVELOPMENT OF SOILS UNDER OIL PALM AFTER DEFORESTATION
(Évolution des sols sous palmeraie après défrichement de la forêt)

Ollagnier, M., Lauzeral, A., Olivin, J. and Ochs, R. (IRHO, 11 Square Pétrarque, Paris 16e, France), *Oleagineux,* 1978, **33,** 537–547.

(In French and English. Spanish summary, 47 lines)

The preservation of the environment and of the soil in particular is indispensable if continuous agricultural production is to be assured. The IRHO therefore undertook to find out the effects on soil development of the techniques used in the establishment and exploitation of an industrial oil palm plantation. The results are reassuring and confirm the soundness of the methods recommended. Research carried out by ORSTOM in the Ivory Coast has shown that the risk of erosion is practically non-existent in an adult plantation when the soil is well protected by the cover plant. For its part, the IRHO has studied the evolution of organic matter, the pH and the absorbent complex for plantations aged from 1–14 years, the soil in question belonging to the large formation of tertiary sedimentary sands (La Mé, Ivory Coast).

It is found that in the year following land clearing, the carbon, total nitrogen and humic acid contents in the windrowed interline rise above those occurring under forest. The contents in the cleared interline, which does not benefit from the dcomposition of the windrow, are at most equal to the initial levels. From then up to 4 years the levels fall to varying degrees according to the element. Thereafter, they stabilise in the top soil (0–30 cm) at 60% of the level under forest for organic matter, 75% for nitrogen, 35% for the humic acids and 65% for the fulvic acids. The dimminution of the C/N ratio shows clearly that there is an acceleration of the mineralisation process. After a considerable increase 1 and 4 years after planting, due to the burning and decay of the windrows, the sum of exhangeable cations in the surface soil levels out at 90% of the content under forest. The rise in the pH in the early years, particularly in the windrow interline, reflects any increase in the saturation rate. Potassium, an essential element, has natural levels in this type of soil which are low for oil palm. It represents less than 10% of the sum of the cations and its evolution is difficult to grasp, but the content seems to increase in the windrowed interline.

The soil under palm plantations therefore tends to evolve towards new a chemical status which proves to be very favourable to the industrial cultivation of several successive generations of oil palm on condition that a certain number of precautions are taken during land preparation and the subsequent exploitation. The problem is the same for coconut which is grown with much the same techniques as oil palm.

SOME ASPECTS OF NATURAL POLLINATION IN OIL PALM (*ELAEIS GUINEENSIS*)

Turner, P. D., (Harrisons Fleming Advisory Services, 1–4 Great Tower Street London, EC3R 5AB, England), *Planter, Kuala Lumpur,* 1978, **54,** 310–328.

This paper places in perspective problems encountered in obtaining commercially adequate fruit set by comparing conditions outside West Africa with those in the oil palm natural environment and natural pollination requirement for continuation of the species. A much-overlooked facet of pollination is that adequate pollination for the palm is totally different from that of commercial requirements. Research requirements have been indicated. A brief description of inflorescences has been given to provide the necessary background information on floral biology.

Pollination by insects (entomophily) is summarised. In most instances, it is concluded that some chance pollination occurs but that this is not consistently adequate for commercial purposes. Studies in areas where a high level of entomophily is indicated is considered worthwhile since it might be possible to introduce pollinators to problem areas. Most natural pollination seems to be by airborne pollen (anemophily) and levels seem to be adequate in older palms where atmospheric conditions are suitable. The depressing effect of rain on the density of airborne pollen is very marked, irrespective of the number of male inflorescences present. Comparative rainfall data are given, with problems being greatest where rainfall is most frequent. Canopy density is a further contributing factor to poor pollination in some instances. Young palms of Malaysian origin provide a special case because of high sex ratio, with inadequate pollen availability irrespective of climate.

ASSISTED POLLINATION ON OIL PALM PLANTATIONS – HARVESTING AND TREATMENT OF POLLEN
(La pollinisation assistée dans les plantations de palmiers à huile – récolte et conditionnement du pollen)

Arnaud, F. (IRHO, 8 Square Pétrarque, Paris 6e, France), *Oléagineux,* 1979, **4,** 175–179.

(In French, English and Spanish)

This IRHO advice note No. 192, up-dates No. 112 in *Oléagineux,* December 1971. It briefly describes the

harvesting, preparation, conditioning and storage conditions for the pollen. It also describes the methods for checking pollen viability and humidity which is carried out before conditioning and use of the pollen.

USE OF THE STOMATA TEST TO MONITOR THE SUPPLY OF WATER IN OIL PALM PLANTATIONS
(Utilisation du test stomatique pour le contrôle de l'alimentation en eau en plantation de palmiers à huile)

Daniel, C. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1979, **34**, 283–287.

(In French, English and Spanish)

This advice note clarifies and completes advice note 19 which appeared in *Oléagineux*, June, 1963. It is necessary to know the level of water supply of palms under irrigation in order to avoid either surplus or deficit. It can also be useful to have data for non-irrigated palms where external factors such as the presence of a water table) can influence water supply, so that to know its level makes it easier to analyse yield figures or other experimental data.

The principle is based on the observation that when well supplied with water an oil palm opens its stomata, whereas it closes them progressively as soil reserves are exhausted. The method of measuring stomata opening uses the Mollish infiltration technique based on the best penetration through narrow openings of liquids with a low surface tension. The application of this principle is described, followed by the steps required in carrying out the stomata test in a plantation. The article concludes with a brief description of the application of the method to the control of irrigation. (IRHO advice note 194).

SOLUBLE GLUCID AND STARCH CONTENTS AND RESISTANCE TO DROUGHT IN THE OIL PALM
(Teneur en glucides solubles et en amidon et résistance à la sécheresse chez le palmier à huile)

Adiahossou, F. (Station du Palmier à Huile, BP 1, Pobé, Republic of Benin) and Da Silva, J. V. (Laboratoire d'Ecologie Générale et Appliquée, Université Paris VII, 4 pl. Jussieu, 75005 Paris, France), *Oléagineux*, 1978, **33**, 599–604.

(In French and English. Spanish summary, 14 lines)

Plants from two lines of *Elaeis guineensis*, one presumed to be sensitive, the other resistant to drought, underwent drought treatment. The rates of starch and soluble sugars were determined in the leaves, the bulbous base of the stem, and the roots. In the normally-watered control plants, a greater accumulation of starch was observed in the bulbous base of the line presumed to be resistant. The drought treatment provoked a significant increase in soluble sugars in the various parts of the plant and there appeared to be transfer of soluble sugars from the bulbous base toward the roots. Resumption of watering resulted in a re-accumulation of glucids in starch form. The role of reserve sugars in resistance to drought in the oil palm is discussed.

A CONTRIBUTION TO THE STUDY OF THE HEIGHT GROWTH OF THE STEMS OF *ELAEIS GUINEENSIS* (JACQ.), STUDY OF THE L2T x D10D CROSS
(Contribution à l'étude de la croissance en hauteur du stripe d'elaeis guineensis Jacq. Etude du croisement L2T x D10D)

Jacquemard, J. C. (La Mé Station, IRHO, BP 13, Bingerville, Ivory Coast), *Oléagineux*, 1979, **34**, 491–497.

(In French and English. Spanish summary, 14 lines)

A foreword by Ch. Surre indicates that this is the first of a series of articles on height growth of the oil palm.

Height growth is an important factor with regard to the profitability of a palm plantation since it determines the length of the exploitation period.

By a study of the control cross (L2T x D10D) planted since 1950 in many different ecological situations, the author has worked on specifying the characteristics of this growth and its heterogeneity. He has shown that the palm grows in diameter, but very little in height, from time of planting until 3 years; that the rate of height growth increases gradually from 3–6 years; that it stabilises at a yearly average value (depending on climatic conditions) from the age of 6–25 years. Knowledge of the heterogeneity also makes it possible to predict the percentage of trees whose crowns will be out of reach once the maximum harvesting height has been defined.

REVIEW OF OIL PALM NUTRITION AND MANURING. SCOPE FOR GREATER ECONOMY IN FERTILIZER USAGE

Ng Siew Kee (United Plantations Berhad, Teluk Anson, Perak, Malaysia), *Oléagineux*, 1977, **32**, 197–209.

(In English and French, Spanish summary, 25 lines)

For maximum fertilizer efficiency, a better appreciation of the nutrient balance and its main components in a given climate-soil-plant context is required. The essential factors of the mineral element balance are: absorption by the plant and leaching losses on the one hand, the quantities supplied by the soil and the fertilizer dressings on the other. The current experimental results then show which approach should be intensified: a better understanding of the palm's mineral element requirements as a function of its age, growth and yield; a better knowledge of the dynamic elements of the soil, particularly potassium and magnesium, so as to estimate the quantities available to the plant. Fertilizer can also be economised by making greater use of nitrogen fixation through symbiosis with legume covers. As regards

leaching losses, they could be reduced by a better choice of the date of application and splitting of the higher rates. Finally, fertilizer efficiency depends on its satisfactory absorption by the roots (mode of application) as well as on the maintenance of a proper balance between the major elements and careful adjustment of the minor element requirements.

STUDY OF TRACE ELEMENT NUTRITION OF OIL PALM AND COCONUT GROWN ON NUTRIENT SOLUTIONS
(Étude de la nutrition en oligo-éléments du palmier à huile et du cocotier cultivés sur solutions nutritives)

Dufour, F. and Quencez, P. (La Mé Station, IRHO, BP 13, Bingerville, Ivory Coast), *Oléagineux,* 1979, **34,** 323–330.

(In French, English and Spanish)

Once the technique of culture of oil palm and of coconut in nutrient solutions had been developed, trials were made to try and induce deficiencies in various trace elements: boron, manganese, iron, zinc, copper, molybdenum. Characteristic deficiency symptoms were observed for boron in oil palm and coconut, and manganese and iron in oil palm only. Zinc and copper deficiencies in oil palms affected growth heavily but no characteristic symptoms were identified. Neither were any anomalies due to molybdenum deficiency identified. Observation of these symptoms is extremely useful for diagnosis of deficiencies in the field, notably for boron which is the trace element most frequently lacking, except for iron and manganese deficiencies, which, however, only appear in special soils of coral origin.

INFLUENCE ON OIL PALM YIELD OF PRUNING AT DIFFERENT LEVELS.
(Influence de l'élagage à différents niveaux sur la production du palmier à huile)

Calvez, C. (Experimentation Service, Robert-Michaux Plantation, Dabou, Ivory Coast), *Oléagineux,* 1976, **31,** 53–58.

(In French and English. Spanish summary, 28 lines)

To reduce the populations of *Coelaenomenodera elaeidis* without destroying its parasite complex, it is possible to resort to severe pruning of the trees during the larval cycle. A trial with the object of measuring the consequences of such a treatment on oil palm yield was set up in the Ivory Coast in 1973; measurements were made of the effects of very severe (up to frond 1) and moderate (up to frond 17) pruning done once at the beginning of the experiment, on the evolution of yield by comparison with a normally maintained control (about 35 leaves). Yield falls very rapidly, to reach a relative minimum of 59% (frond 17) and 3% (frond 1) of the unpruned control 12–15 months after pruning. Cumulatively over 3 years, yield losses amount to 8 tonnes/bunches/ha (frond 17) and 26 tonnes (frond 1) or 16% and 56% of the yield of the unpruned control. The balance is still not final, as losses were still 10% and 58% of the control in the third year of observati Furthermore, the amplitude of these losses gives an appro mate idea of the consequences of defoliation by *Coelaeno menodera* itself; severe defoliation resulting from a pullati can lead, therefore, to considerable losses, but the aspect of the loss curve in function of the degree of pruning shows that a 20–30% defoliation does not have very serio consequences (about 5% losses over 3 years). These findin will be a useful aid to decision-making in case of an attack.

MECHANICAL CULTIVATION AND UPKEEP OPERATIONS

Choa, S. L. (Universiti Pertanian Malaysia, Serdang, Selang Malaysia), *Planter, Kuala Lumpur,* 1979, **55,** 290–300.

Maintenance and upkeep operations are necessary as soon as the crop is planted. The crop must be protected from weeds and the soil against erosion. Diseases and pests must be reduced to a level tolerated by the crop, whilst the latter at the same time has to be supplied with the appropri ate nutrients essential to growth, development and produc tion. Roads and drains must not be neglected.

Cover crop planting preceded by applications of chemical pre-emergence herbicide followed by inter-row cultivation in the early stages of the cover and fertilizer application are typical activities. As the crop grows and throughout its economic life, it may be possible to mechanise some main tenance upkeep operations. Strip weeding, inter-row slashi or spraying of weeds, fertilizer application and certain aspects of pest disease control, e.g. trenching, spraying and dusting, are some of these operations. Maintenance of road and drains are not to be excluded from the list of mechan ised operations.

The paper discusses some of the pre-requisites of successful mechanisation. A method of estimating the cost of operati of agricultural machinery is suggested. The recommendatio of the type of equipment suitable for use in various culti vation upkeep operations is given in an appendix.

Weeds, pests, diseases and their control

THE ECONOMICS OF CROP PROTECTION IN OIL PALMS

Wood, B. J. (Chemara Research Station, Seremban, Malays *Planter, Kuala Lumpur,* 1978, **54,** 620–642.

Crop protection economics involves more than simple cost accounting, as demonstrated by examples of problems in oil palms. Complicating factors are disturbances to ecologi

al stability, difficulties in assessing the effect of damage or ompetition on oil yield, and often a long time between ause and effect. Information on all these aspects is needed or proper economic evaluation which is vital to decision aking.

EEDING OF PERENNIAL OIL CROPS–PARTICULAR ASES OF YOUNG CROPS AND CONTROL OF HARM-UL WEEDS

Désherbage des oléagineux pérennes – Cas particuliers des eunes cultures et de la lutte contre les adventices nuisibles)

elorme, M. (IRHO, Port-Bouët Station, Ivory Coast), *léagineux*, 1979, **34**, 1–6.

In French and English, Spanish summary, 19 lines)

eriodic maintenance of the circles in young plantations is or two purposes: to eliminate the weeds in the immediate roximity of the roots, and to protect the young plant from he legume cover. The two objectives lead to dividing the reatments into two separate rounds, for each of which the ffectiveness of several herbicide products is discussed. The esults to date support the opinion that, in spite of its cost, hemical maintenance will be practised increasingly, given he increasing cost and scarcity of manpower. Moreover, a ertain number of specific problems may appear, among hich invasion of the inter-rows by *Eupatorium* and *mperata* is the most tiresome. Satisfactory results have een obtained against *Eupatorium* with phytohormones, ertain residual herbicides, glyphosate or pichloram, but all hese treatments must be effected with caution, and after lashing of the weeds. Concerning *Imperata*, glycophosate an be recommended thanks to its high degree of efficiency.

ALANG (*IMPERATA CYLINDRICA*)–A POSSIBLE COLOGICAL FUNCTION

ajaratnam, J. A. (Sabah Tea Sdn, Bhd, Sedco Complex, ota Kinabalu, Sabah, Malaysia), *Planter, Kuala Lumpur*, 978, **54**, 409–413.

he commonest and most dreaded weed in the agricultural ystem of the Asian region and perhaps the humid tropics is *mperata cylindrica*, commonly called 'lalang' in Malaysia nd Indonesia. In fact it has been considered as one of the 0 worst weeds in the world. In Malaysia, Lalang grows rofusely on any cleared land, on most soil types, and can ow well up to altitudes of 1,200 m (4,000 feet) but does ot appear to occur in higher altitudes. For example, the Pinasok Plateau (at the foothills of Mount Kinabulu) here an area of about 0.4 ha (1 acre) has been cleared for a elicopter pad at about 1,500 m (5,000 feet) about 7 years go, no lalang has been observed so far, but at Kundasang, hich is about 330 m (1,000 feet) below, sheet lalang can be bserved.

TECHNIQUES FOR THE CHEMICAL CONTROL OF *EUPATORIUM ODORATUM* IN PALM OIL PLANTATIONS (Techniques de lutte chimique contre *Eupatorium odoratum* en palmeraie)

Dufour, F., Quencez, P. and Boutin, D. (IRHO Station, La Mé, BP 13, Bingerville, Ivory Coast), *Oléagineux*, 1979, **34**, 223–227.

(In French and English. Spanish summary, 11 lines)

Eupatorium odoratum is an introduced weed which has extended throughout West Africa. Its presence in large populations in plots of young oil palms can seriously compromise their development. This article describes methods of chemical treatment with the aid of two products: Roundup (Monsanto) and Tordon 101 (Dow) in three different situations: the treatment of borders and fallows, preparation of plots for replanting and the treatment of regrowth in young plant groves. The costs of manual and chemical treatments are compared.

OIL PALM PESTS IN LATIN AMERICA

Anon., *Oléagineaux*, 1978, **33**, XVIII, XIX, 326–419.

(In French, Spanish and English)

This special issue is devoted to oil palm pests (insects and mites) in Latin America. A double page is devoted to each pest, each of which is illustrated by a photograph of the adult and photographs of the earlier stages for most species. Some of the photographs are in colour. The text indicates the part of the palm attacked, the stage at which the pest is harmful, its geographical location, a brief description of the insect, its biology, the damage resulting from it, surveillance and critical threshold, control and other observations. In addition, the pests are tabulated in the form of an index indicating economic incidence and plant organs attacked and there is also an index of insecticides mentioned.

MECHANISATION OF ESTATE SPRAYING

Bloomfield, A. (Plant Protection Ltd., Fernhurst, England) and Khoo, K. M. (Sime Derby Plantations Bhd. Kuala Lumpur, Malaysia) *Planter, Kuala Lumpur*, 1979, **55**, 125–131.

The area of oil palm and rubber is increasing by approximately 47,000 to 54,000 ha (116,000 to 134,000 acres)/year and in many areas there are not enough staff to carry out operations at the optimum timing to realise the full crop potential. Estate spraying is one of the tasks that absorbs much time and has a high labour requirement, and with mechanisation this would release men for harvesting and other estate duties.

Mechanisation is clearly not applicable to all areas because of difficult terrain and restricted access, but if practised in

those areas where it is practical, it is argued that it would release more labour to deal with the difficult areas.

The mechanised estate sprayer described is a specially adapted version of a well-proven field crop sprayer, with the normal wide boom used for crop spraying replaced by a robust adjustable boom designed to carry nozzles on the outer extremities. These are designed for fixed spraying, but in addition, the sprayer is fitted with alternative systems for operators to use hand lances or hand-carried booms. The equipment and its operation is described and work rates are estimated to be 3–4 times faster than knapsack application dependent on the area being sprayed and the number of operations.

AERIAL TREATMENTS OF INDUSTRIAL OIL PALM PLANTATIONS. I–MATERIAL AND ORGANISATION. II–METHOD OF TREATMENT
(Traitements aériens des plantations industrielles de palmiers á huile. I–Le matériel et L'organisation. II–La réalisation)

Genty, Ph. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1977, **32**, 5–8; 51–54.

(In French, English and Spanish)

Aerial treatment is proposed in plantations where topographical conditions make it impossible to control insects with standard ground treatment equipment. Part I briefly describes the type of aircraft and spraying equipment, the organisation of the air strip and of the treatment work site, while part II describes how an aerial treatment should be carried out on an oil palm plantation. (IRHO advice notes 168 and 169).

PHYTOSANITARY CHECKS ON ADULT OIL PALM PLANTATIONS IN WEST AFRICA. II–SPECIAL CHECKS
(Contrôles sanitaires des plantations adultes de palmiers à huile en Afrique de l'Ouest. II–Contrôles spéciaux)

Morin, J. P. and Philippe, R. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux,* 1978, **33**, 429–434

(In French, English and Spanish)

This continues IRHO advice note 184 (*Oil Palm News* (1979) (23), p.28) dealing with ordinary phytosanitary checks. If the observers note the abnormal presence of a pest (generally swarming of *Coelaenomendera* or defoliating caterpillars) supplementary checks called 'special checks' must be made.

The primary purpose for these special checks is to determine the extent of the focus and the exact level of the populations. Their pursuit and frequency depend on the pest and on the seriousness of the attack, and concern only the infested area. Ordinary controls go on as usual throughout the rest of the plantation and thus it may be advisable to train an extra team. The procedures for checks on the swarming of *Coelaenomenodera* and for defoliating caterpillars are described. (IRHO advice note 185).

METHOD OF CONTROL OF (*COELAENOMENODERA COLEOPTERA*: HISPIDAE BY INJECTION OF SYSTEM INSECTICIDES INTO THE OIL PALM TRUNK
(Méthode du lutte contre *Coelaenomenodera (Coleoptera:* Hispidae) par injection d'insecticides systémiques dans le stipe du palmier à huile)

Mariau, D. (IRHO, Port-Bouët Station, 07 BP 13, Abidjan 07, Ivory Coast. Philippe, R. and Morin, J. P. (IRHO, La Mé Station, BP 13, Bingerville, Ivory Coast), *Oléagineux,* 1979, **34**, 51–58.

(In French and English. Spanish summary 20 lines)

Coelaenomenodera elaeidis is a hispid Coleopteron whose larvae are oil palm leaf miners in West Africa.

Standard treatments from the air or the ground give very irregular results and prove particularly toxic for the predato and parasite entomofauna.

A method has been worked out which consists of injecting a systemic insecticide into the trunk, whence it is carried by the sap and distrubuted throughout the leaf crown of the palm. The studies concerned the injection technique, the screening of insecticides, the best moment of the life cycle of the insect to take action, residues in the leaves and fruit and the trauma incurred by the palm.

Monocrotophos alone proved really effective at the rate of 14 g active ingredient per tree. The treatment is mainly efficient against the adults and is principally concentrated in the youngest leaves. Mortality is close to 100% and the palm suffers little from the lesions made for the injection. No insecticide residue has been found in the fruit. The type of treatment only has a slight indirect effect on the predators and parasites. (See also IRHO advice note 193 below – Editor).

METHOD OF CONTROL OF *COELAENOMENODERA* BY INTRODUCTION OF SYSTEMIC INSECTICIDE INTO THE OIL PALM TRUNK
(Méthode de lutte contre *Coelaenomenodera* par injection d'insecticides systémiques dans le stipe du palmier á huile)

Philippe, R. (IRHO Station, La Mé, Ivory Coast), and Diarrassouba, S., (Palmindustrie, D2T, BP V239, Abidjan, Ivory Coast), *Oléagineux,* 1979,**34**, 229–233.

(In French, English and Spanish)

This note describes the method of treatment, materials required, organisation of the work site, the best period for treatment and a brief discussion of the factors to be taken into account in a decision to treat and the area to be treated. Although the treatment is relatively costly and

time-consuming, it is remarkably effective, the death rate being close to 100%. No insecticide residue has been detected in the oil, even when cold extracted. (IRHO advice note 193).

CONTRIBUTION TO THE BIOLOGICAL CONTROL OF *COELAENOMENODERA:* INTRODUCTION OF PARASITES OF HISPINAE LARVAE TO THE IVORY COAST

(Contribution à la mise au point d'une lutte biologique contre *Coelaenomenodera*: introduction en Côte-D'Ivoire de parasites larvaires d'hispines)

Philippe, R., Desmier de Chenon, R., Lecoustre, R. (Entomology Service, IRHO Station, La Mé, BP 13, Bingerville, Ivory Coast) and Mariau, D. (Director of Entomology Department, Mare-Delorme Coconut Station, BP 13, Abidjan 07, Ivory Coast), *Oléagineux,* 1979, **34**, 271–279.

(In French and English. Spanish summary, 22 lines)

When *Coelaenomenodera,* the worst enemy of the oil palm in West Africa, enters into a phase of intensive multiplication, its well-marked generations no longer overlap and this reduces the efficiency of its larval parasites to a considerable extent the more so in that the young larvae (first and second stage) are very little parasitised, if at all. An attempt was therefore made to fill this gap in the pest's parasite complex by introducting various parasites of Hispinae which attack oil palm or coconut. Thus, as a result of several missions, parasites were imported from the New Hebrides (*Pediobius parvulus* Ferr.), Colombia (*Bracon* sp. and *Tetrastichus* sp.), and Malaysia (*Pediobius parvulus* Ferr. and *Sympiesis javanica* Ferr.). The breeding of such parasites in the laboratory is more or less easy according to the species. Releasing them in different palm plantations has led to the installation of *Pediobius parvulus* only (New Hebrides strain), but the population of this species is still very small and its role in limiting foci of *Coelaenomenodera* swarming is consequently nil; as it only attacks the latter larval stages of the pest, it is in direct competition with the local larval parasites, which have the advantage of being better adapted to the climate.

THE OIL PALM BUNCH MINER, *CASTNIA DAEDALUS* (CRAMER) ON THE TOCACHE PLANTATION, PERU

(El barreno de los racimos de la palma aceitera, *Castnia daedalus* (Cramer), en la plantacion de Tocache, Perú)

Korytkowski, C. A. (Jefe del Servicio de Entomologia, Emdepalma, S. A., Javier Prado, Oeste No. 1259, San Isidro, Lima, Peru) and Ruiza, E.R. (Jefe del Laboratorio de Entomologia, Emdepalma S.A.), *Oléagineux,* 1980, **35**, 1–11.

(In Spanish and French. English summary, 20 lines)

On the oil palm plantation at Tocache, Peru, there have been very heavy yield losses (30–40%) since harvesting started on the earliest planting. These have been due to a Lepidopteron, *Castnia daedalus,* whose larvae burrow into the stem and the bunches, which rot partially or completely. The adult is a large moth with a wing span of 170–205 mm; which is active at dusk. The female usually lays around the immature bunches, the average is 265 fusiform eggs 5–6 mm long. Incubation lasts 16 days. The creamy white larvae, which roughly resemble those of the Cerambycidae, quickly tunnel into the stem and bunches. They grow to a great size (110–130 mm) after a lengthy development of 233 days which includes 14 larval stages. Prepupation takes place within a fibrous cocoon in the leaf base under the crown and lasts 30 days. The total life cycle is very long, about 300 days on an average. The author observed natural mortality on one generation and estimated it to be about 93% at Tocache. Amongst the rare natural enemies, he mentions a Hymenopteron parasitising the eggs, Sarcophagidae Diptera, which are parasites of the prepupae, and predators such as ants and beetles.

SOME PREDATORS AND PARASITES OF *MAHASENA CORBETTI* (TAMS) AND *THOSEA ASIGNA* (MOORE) IN SARAWAK

Tiong, R.H.C. (Sarawak Land Development Board, Miri, Sarawak, Malaysia), *Planter, Kuala Lumpur,* 1979, **55**, 279–289.

Mahasena corbetti and *Thosea asigna* larvae outbreaks have occurred on a few occasions (1976/1977) in the oil palm plantations of the Sarawak Land Development Board, causing immense foliage damage to the palms. Between 1976 and 1978, several species of predacious and parasitic insects, fungi and viruses on the two pests have been identified. They were bugs of *Cosmolestes picticeps, Isyndus heros* and *Sycanus macracanthus* preying on the early stages of larvae of both *M. corbetti* and *T. asigna;* beetles of *Allecula minuta*; *Allecula* sp.; *Litotarsus* sp.; and *Myrmarachne* sp. associated with the death of *M. corbetti* larvae and pupae; wasps of *Brachymeria lugubris; B. ghani* and *Echthromorpha agrestoria* flies of *Eozenillia* sp. parasitising *M. corbetti* larvae and wasps of *Chlorocryptus* sp. nr. *coeruleus* parasitising *T. asigna* pupae.

Entomogenous fungi *Paecilomyces fumosoroseus* on *Mahasena corbetti* larvae and *Cordyceps militaris* on *Thosea asigna* pupae; non-occluded RNA virus on *M. corbetti* and occluded RNA virus on *T. asigna* larvae have also been identified. It was found that *C. militaris* was hydrophilous, growing vigorously when the moisture content of its food base (*T. asigna* pupae) was 53.7%.

These organisms might be potential biological control agents against the two pests. Further studies of the culture, multiplication and propagation of the former would be required.

RESEARCH ON *ORYCTES MONOCEROS* OL. IN IVORY COAST. II – TRIAL OF BIOLOGICAL CONTROL BY *RHABDIONVIRUS ORYCTES*

(Recherches sur l'*Oryctes monoceros* 01. en Côte-d'Ivorie. II – Essai de lutte biologique avec le virus *Rhabdionvirus oryctes*)

Julia, J. F., (IRHO, Port Bouet Station, Ivory Coast) and Mariau, D. (IRHO Station, La Mé, Ivory Coast), *Oléagineux*, 1976, **31**, 113–117.

(In French and English. Spanish summary, 19 lines)

Rhabdionvirus oryctes was successfully introduced into different islands in the South Pacific to control *Oryctes rhinoceros*. Similar trials were carried out, first in the laboratory at Darmstadt, then in the Ivory Coast, on two African species harmful to the coconut, *O. monoceros* and *O. boas*, the former having by far the greatest economic significance. *O.boas* showed a sensitivity to the virus close to that of *O. rhinoceros* but the *monoceros* species was found to be much less sensitive, and even at extremely high doses the larvae do not present the typical symptoms of the disease, although a certain mortality is noted. The progeny of adults developed from larvae raised in a virus-infected medium do not suffer any anomalies. In view of these results, field trials were not undertaken.

FIRST RECORD OF *SESAMIA PEOPHAGA* (LEPIDOPTERA, NOCTUIDAE) ON OIL PALM

Agwu, S.I. et al (Entomologist, NIFOR, Near Benin City, Nigeria), *Journal of the Nigerian Institute for Oil Palm Research*, 1978, **5**, 97–99.

A noctuid, *Sesamia poephaga*, attack of oil palm polybag seedlings is described for the first time. Affected seedlings exhibit wilting and then withering of the central whorl of leaves and these come off easily if pulled. Attacks of seedlings of up to the 2–4 leaf stage result in death of seedlings; older seedlings may, however, survive. An estimated 1.7–7.4% seedling mortality from *S. poephaga* attacks was recorded, but the levels of infestation appeared to vary with locality and seedling age. In the laboratory, larvae pupated under the leaf bases or in the polybag soil.

VIRUS DISEASE OF DENSONUCLEOSIS TYPE IN THE LEPIDOPTERA *SIBINE FUSCA* STOLL

(Une virose de type densonucléose chez le lépidoptère *Sibine fusca* Stoll)

Meynadier, G., Amargier, A. (Station de Recherches de Pathologie comparée INRA, 30380 St. Christol-les-Alès, France) and Genty, Ph. (INDUPALMA, Bogota, Colombia), *Oléagineux*, 1977, **32**, 357–361.

(In French and English. Spanish summary, 10 lines)

A virus infection of densonucleosis type has been shown in *Sibine fusca* (Lepidoptera), a pest of the oil palm. Size, shape and structure of the virions exhibit characters peculiar to Parvoviridae belonging to the *Densovirus* genus. Nuclear lesions are similar to those observed in other insects infected with densonucleosis, but important tumour-like formations, particularly in the gut, have not so far been noted in other cases.

MORPHOLOGY AND BIOLOGY OF A DEFOLIATING LEPIDOPTERON OF THE OIL PALM IN LATIN AMERICA *STENOMA CECROPIA* MEYRICK

(Morphologie et biologie d'un lépidoptère défoliateur du palmier à huile en Amérique latine, *Stenoma cecropia* Meyrick)

Genty, Ph. (Entomologist, San Alberto, Bucaramanga, Colombia), *Oléagineux*, 1978, **33**. 421–427.

(In French and Spanish. English summary, 12 lines)

The Stenomid lepidopteron *Stenoma cecropia* M. is a highly polyphagous defoliator which has adapted to oil palm in Latin America over the past few years. Damage can be very extensive, as observed in Colombia and more recently in Ecuador, and occurs at all levels of the foliage, in serious attacks leaving nothing but the leaf veins, to which the protective capsules of the larvae cling. The insect and its damage are described; effective control can be achieved by aerial treatment with trichlorfon. Natural control of *Stenoma*, which is very weak, consists principally of Braconidae: *Rhysipolis* sp. on the caterpillar and several Chalcididae on the pupa; they rarely obviate the need for chemical treatment.

CONTROL MEASURES AND OBSERVATIONS IN SOME *VALANGA NIGRICORNIS* OUTBREAKS IN OIL PALMS IN PENINSULAR MALAYSIA

Han, K. J. and Chew, P. S. (Highlands Research Unit, Klang, Selangor, Malaysia), *Planter, Kuala Lumpur*, 1978, **54**, 682–691.

Four serious outbreaks of the grasshopper *Valanga nigricornis* occurred in young oil palm areas, three in an estate in the Keratong and one in Kota Tinggi, causing considerable damage to the foliage. This paper discusses the observations on damage by the pest and results of aerial spraying with monocrotophos, dicrotophos and methamidophos to control the pest in these outbreaks.

Results of an insecticide trial with mist blowers testing monocrotophos, methamidophos, dicrotophos and phosmet to control the pest are also discussed.

Good results were obtained with monocrotophos, dicrotophos and methamidophos. Monocrotophos is the cheapest and being less likely to upset insect populations in the sprayed areas compared to some existing chemicals used, is recommended at 300 cm^3 in 17 litres/ha to be aerial sprayed.

RATS AS AGRICULTURAL PESTS IN MALAYSIA AND THE TROPICS

Wood, B. J. and Liau, S. S. (Guthrie Research, Chemara, Jalan Labu, Seremban, Malaysia), *Planter, Kuala Lumpur*, 1978, **54**, 580–599.

This article surveys the species of rats in Malaysia which are pests, describes methods of control, and potential losses in oil palms and other crops. It is concluded that studies of population have enabled effective control measures to be developed by eliminating rat populations. Though in crop monocultures such as oil palm, one pest species normally predominates, this may not necessarily be the same species in all the circumstances in which the oil palm is grown.

OIL PALM, A SOURCE OF FOOD FOR SOME LARGE-BILLED CROWS

Chua, T. H., Siew, Y. C., Ng, S. M., Fong, F. W. and Lee, T. H. (Department of Zoology, University of Malaya, Kuala Lumpur, Malaysia), *Planter, Kuala Lumpur*, 1980, **56**, 44–45.

The authors report evidence that not only does the house crow, *Corvus splendens* Vieillot feed on oil palm fruit but also another species, *C. macrorhynchos macrorhynchos* Wagler, the large-billed crow. The authors consider that with the present trend of centralisation of abattoirs resulting in a reduction of an important food source, the crow may increasingly move towards oil palm fruit as an alternative food source.

DISEASES AND ANOMALIES OF THE OIL PALM IN THE NURSERY
(Les maladies et anomalies du palmier à huile en pépinière)

Renard, J. L. and Quillec, G. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1979, **34**, 331–337.

(In French, English and Spanish)

The authors describe various nursery diseases including *Cercospora* leaf spot, blast and dry bud rot together with various other leaf diseases and some anomalies of non-pathological origin such as crown disease, chlorophyll deficiency and boron deficiency. (IRHO advice note 195).

DISEASES OF OIL PALM AND THEIR RELATION TO THOSE OF COCONUT

Mathai, G. (Assistant Professor, Coconut Research Station, Kumarakom, Kottayam, Kerala, India), *Indian Coconut Journal*, 1979, **10**, (June), 1–3.

This paper presents the salient features of important diseases affecting oil palm so as to enable them to get wider attention by the researcher as well as the cultivator. It is also intended to warn those in the field of oil palm cultivation regarding the seriousness of the situation while resorting to intensive cropping of the same. The paper considers both nursery and field diseases and their control. Many of the diseases described in oil palms are also reported in coconut palms from different parts of the coconut-growing countries.

ANOMALIES OF GENETIC ORIGIN IN THE OIL PALM, *ELAEIS*. DESCRIPTION AND RESULTS
(Anomalies d'origine génétique chez le palmier à huile *Elaeis*. Description et résultats).

Gascon, J. P. and Meunier, J. (Plant Breeding Department, IRHO, BP 5035, 34032 Montpellier, Cedex, France), *Oléagineux*, 1979, **34**, 437–447.

(In French and English. Spanish summary, 14 lines)

Certain anomalies of the vegetative organs (ramification, twisted fronds, torch, crown disease, chlorophyll deficiencies, little leaf) and of the reproductive system (viviparity, sterility, gynandromorphism) may be due to simple hereditary factors. These anomalies, generally very unfavourable, are usually eliminated before planting. It is important however to note and count them in the nursery. Knowledge of these marker genes is useful for the plant breeder who can verify the identity of certain material, and thus prevent these disorders appearing in the plantations. This article describes the main hereditary anomalies, some of which should not be confused with symptoms of malnutrition or disease.

DEMONSTRATION OF THE ROLE OF *RECILIA MICA* KRAMER (HOMOPTERA, CICADELLIDAE, DELTOCEPHALINAE) IN BLAST DISEASE IN OIL PALM NURSERIES IN THE IVORY COAST
(Mise en évidence du rôle de *Recilia mica* Kramer (Homoptera, Cicadellidae, Deltocephalinae) dans la maladie du blast des pépinières de palmiers à huile en Côte-d'Ivoire)

Desmier de Chenon, R. (IRHO Station, La Mé, BP 13, Bingerville, Ivory Coast), *Oléagineux*, 1979, **34**, 107–115.

(In French, English and Spanish summaries, 19 and 21 lines)

The fungi *Pythium* and *Rhizoctonia* were long considered to be the causes of blast disease. But it was possible to reproduce it by successive and selective introduction of stinging insects, possible pathogen vectors, into cages containing healthy palms. Amongst the hundreds of species of insects tested, *Recilia mica* is shown to be the only species involved in the appearance of blast. The death rate of the plants in cages with *Recilia* is virtually 100% and transmission of the disease is very rapid, more or less in a fortnight. The grasses *Paspalum* and *Pennisetum* are the hosts of this leaf-hopper, and it is only at one very specific time of the year, October and November, that the populations move on to the palm. A method of cultivation eliminating the maximum amount of grasses, primary hosts

of *Recilia*, reduces blast cases considerably. However, a very satisfactory result is always obtained by applying Temik each month at the start of the nursery period. This method makes it possible to do without shading which used to be recommended and the plants develop very much better.

ISOLATION AND IDENTIFICATION OF INSECTS CARRYING JUVENILE DISEASES OF THE COCONUT AND THE OIL PALM IN THE IVORY COAST

(Mise en évidence et identification des insectes responsables des madadies juvéniles du cocotier et du palmier à huile en Côte-d'Ivoire)

Julia, J. F. (Entomology Department, Marc-Delorme Coconut Station, IRHO, BP 13, Abidjan 07, Ivory Coast), *Oléagineux*, 1979, **34**, 385–393.

(In French and English. Spanish summary, 17 lines)

The author describes the symptoms of two juvenile diseases affecting the oil palm and coconut in the Ivory Coast and summarises previous results of research on vector insects. A method of study is described involving 'insect-proof' cages to determine whether blast or dry bud rot are respectively identical and transmitted by the same vector insect or insects on both plants. The results of introducing several Hemiptera, dissections of the male genitalia of *Recilia* sp., observations on Delphacidae and finally signs of disease verified by dissection of the plants are all described. It is concluded that blast is transmitted by *Recilia mica* (Jassidae, Deltocephalinae) on the oil palm and coconut and that dry bud rot is transmitted by one or several species of the Delphacidae family alone on both plants.

CURRENT IRHO RESEARCH ON COCONUT AND OIL PALM WILTS IN SOUTH AMERICA ASSOCIATED WITH INTRAPHLOEMIC FLAGELLATE PROTOZOA (*PHYTOMONAS*)

(Recherches actuelles de l'IRHO sur les dépérissements du cocotier et du palmier à huile en Amérique du Sud associés aux protozoaires flagellés intraphloemiques (*Phytomonas*))

Dollet, M. (Virology Department, IRHO-Gerdat, BP 5035, 34032 Montpellier-Cedex, France), Lopez, G., Genty, Ph. (INDUPALMA, Ap. Aereo 1535, Bucaramanga, Colombia) and Dzido, J. L. (Palmeras de los Andes, Bosmediano 11.67, Casilla 5115–Quito, Ecuador), *Oléagineux*, 1979, **34**, 449–452.

(In French and English. Spanish summary, 24 lines)

On the West Coast of Ecuador, between Santo Domingo and the ocean, coconuts suffer from wilts generally suspected of being 'red ring'. Now, systematic checks show that in about 80% of cases flagellate protozoa are involved. A study of the weeds found near oil palm or coconut plantations in Ecuador has revealed 5 different species of *Euphorbia* and one Asclepiadaceae harbouring flagellates. Two species of *Euphorbia, E. prostrate* Ait.(?) and *E. foliolosa* Boiss.(?) seem to suffer from this infection. Moreover, the latter is often seen in the palm circles in plantations. The others manifest no symptoms but *E. hirtella* Boiss.(?) is 90% infected close to certain coconut plantations. *Asclepias curassavica* L. is also host to flagellates, but without symptoms. In a mixed plantation of coconut and cocoa we noted a cocoa-tree suffering from a wilt similar to that of phloem necrosis of the coffee-bush, a flagellate disease. Chemotherapeutic trials have been done *in vitro* and by injection in the diseased palms with different products supplied by Rhône-Poulenc (Centre de Recherches Nicolas Grillet, Vitry, France) – pentamidine dichlorhydrate, isometamidium chloride, stilbamidine isothionate, and with endrine, the insecticide used preventatively against marchitez in oil palms.

PROTECTION AGAINST CERCOSPORA LEAF SPOT OF THE OIL PALM

(Protection contre la cercosporiose du palmier à huile)

Quillec, G. and Renard, J. L. (IRHO, 8 Square Pétrarque, Paris 16e, France), *Oléagineux*, 1977, **32**, 363–365.

(In French, English and Spanish)

Experiments in the nursery and in the field have shown that the application of fungicides to the leaves greatly improves the health of the plants both in the case of *Elaeis guineensis* and with *E. melanococca* (syn *oleifera*) and the hybrids between the two species. Four effective fungicides are listed and recommendations are given for treatments in the pre-nursery, the nursery and in the field.

HEREDITY OF RESISTANCE TO *FUSARIUM* WILT IN THE OIL PALM *ELAEIS GUINEENSIS* JACQ.

(Hérédité de la résistance à la fusariose chez le palmier à huile *Elaeis guineensis* Jacq.)

Meunier, J. (Selection Department, IRHO, IRHO/Gerdat, BP 5035, 34032 Montpellier-Cedex, France), Renard, J. L. and Quillec, G. (Phytopathology Department, Plantation R. Michaux, BP 8, Dabou, Ivory Coast), *Oléagineux*, 1979, **34**, 555–561.

(In French. English and Spanish summaries 14 and 18 lines)

Fusarium wilt caused by *F. oxysporum* is the most serious oil palm disease in Africa. The *Elaeidis* sub-species, first isolated in 1946, can cause major damage in the Ivory Coast savannah. Observation of marked differences in selected planting material (differences between crosses) has led the IRHO to seek a genetic solution to the problem, the more so as inoculation of the disease and the development of precocious pre-nursery tests have shown this research to be

promising. Numerous trials and thousands of tested crosses of oil palms have made it possible to distinguish parents which transmit resistance factors and draw up crossing plans leading to the production of seed tolerant to the disease. The research described here gives fresh details on the heredity of this tolerance; major progress by phenotypical selection can thus be foreseen.

EVALUATION OF OIL PALM PROGENIES FOR REACTION TO THE VASCULAR WILT DISEASE

Rajagopalan, K., Aderungboye, F. O. (NIFOR, Near Benin City, Nigeria), Obasola, C. O. and Eme, A. *Journal of the Nigerian Institute for Oil Palm Research*, 1978, **5**, 87–95.

In a modified Prendergast's technique, fresh topsoil was used in filling polythene bags for raising test oil palm seedlings whose roots were thoroughly washed with a jet of tap water before inoculation with 10 ml of a mixture of ten isolates of *Fusarium oxysporum* collected from different oil palm growing areas of Africa. This modified technique was standardised and subsequently used for screening oil palm progenies for their reaction to the vascular wilt disease.

Although none of the 336 test progenies was found to be immune to the disease, 149 progenies were selected as wilt tolerant and are currently being used at NIFOR for large-scale production of wilt-tolerant seeds.

The data obtained also showed that *pisifera* parent palms found to be tolerant to the disease were capable of transmitting this desirable attribute to their hybrids. A similar trend was indicated by Deli *dura* parents but the data were insufficient to be conclusive.

SOME ARBORICIDE INVESTIGATIONS ON OIL PALMS

Ian, K. J. (Syarikat Penyelidikan Pertanian Barlow Boustead Sdn Bhd, Highlands Research Unit, Klang, Selangor, Malaysia), *Planter, Kuala Lumpur,* 1979, **55**, 371–376.

The ban on the use of sodium arsenite imposed by the Malaysian Government has given rise to renewed interest in finding a substitute for sodium arsenite for the purpose of poisoning old oil palm stands prior to felling for replanting. A series of experiments was initiated to test out some commonly available herbicides for their aboricidal activity in oil palms under Malaysian conditions. The results indicated that the two bipyridyl herbicides, diquat and paraquat, can be used as substitutes for sodium arsenite for the purpose of palm poisoning at 22.7 g active ingredients per palm applied in 2 downward sloping holes. In a coastal soil situation, it may be advisable to apply at slightly higher rates. Palms can be felled at 30 days after treatment.

Palm fruit handling and processing

FIELD FACTORS AFFECTING QUALITY

Southworth, A. (Quality Control Department, c/o Guthrie Research, Chemara, Seremban, Negri Sembilan, Malaysia), *Planter, Kuala Lumpur*, 1979, **55**, 440–451.

On estates, attention to quality must be part of the overall aim of maximising the profit margin. The standard and frequency of harvesting can be calculated to give the optimum compromise between collection cost, quantity and free fatty acid level of oil. After harvesting, fruit must be handled and transported gently and rapidly, and dirt pick-up minimised in view of its effect on oxidation.

PRODUCTION OF PALM OIL IN RELATION TO QUALITY

Bek-Nielsen, B. (United Plantations Berhad, Teluk Anson, Perak, Malaysia), *Planter, Kuala Lumpur,* 1979, **55**, 452–466.

It is possible to produce high quality palm oil with current technology. Many aspects of milling can affect quality. Copper and other heavy metal contamination should be avoided and iron pick-up minimised by a low, free fatty acid level, coated or stainless steel equipment and other measures. Oxidation can be controlled by avoiding exposure of hot oil to air and the use of carbon dioxide blankets.

TREATMENT OF OIL PALM FRUIT

Wood, B. J. and Koo Pai Sing, *British Patent Specification 1,463,565,* 2 February 1977, 3 pp.

This patent describes a process for loosening the fruit from the bunch prior to stripping by exposing the bunch to a gaseous mixture of air and an unsaturated aliphatic hydrocarbon, such as acetylene, ethylene, propylene or butylene, or chemical derivatives of these hydrocarbons. It is claimed that loosening the fruit in this way means that a much more limited heat treatment such as to 80°C for 30 minutes would be sufficient for sterilisation.

One convenient treatment involves exposing the bunches at ambient temperature and pressure for from 15 to 20 hours to air containing 1–3% of ethylene or acetylene. Ripening may be hastened by reducing the carbon dioxide concentration of the gas in contact with the bunches, for example by using an adsorbent such as sodium hydroxide for carbon dioxide.

The invention is claimed to have the following advantages:

(a) It overcomes the disadvantages of steam heat treatment, namely loss of 2–3% of oil in the empty bunches and the production of a condensate that presents

effluent problems, and is expected materially to cheapen the separation of the fruit from the bunch.

(b) Most bunches are produced free of oil so that there is more possibility of their profitable use as by-products.

(c) It makes process testing and control easier.

(d) The development of this process may allow the development of solvent extraction techniques without the sterilisation step.

(e) It would allow the establishment of a stripping and sterilising facility on individual estates away from the central mill, leading to an economy in transport costs.

THE INDUSTRIAL EXTRACTION OF PALM OIL
(L'extraction industrielle de l'huile de palme)

Fonade, E. (SPEICHIM, 104, Rue Edouard-Vaillant, BP 12, 93140 Bondy, France), *Revue française des Corps Gras,* 1979, **26**, 59–62.

(In French. English, German and Spanish summaries, 7, 8 and 10 lines)

The processing of palm fruit for the extraction of palm oil and palm kernels is described.

WHY SOLVENT EXTRACTION OF PALM OIL IS NOT TO BE RECOMMENDED

Tjeng, T. D. and Olie, J. J. (Stork Apparatenbouw B. V., Amsterdam, Holland), *Oléagineux*, 1975, **30**, 523–528.

(In English. French and Spanish summaries, 14 and 13 lines)

Palm oil is produced by mechanical expellers from the mesocarp of the fruit, whilst solvent extraction is usually applied to the extraction of seed oils. Palm fruit mesocarp has a very different composition from oil seeds, particularly with regard to oil/water/solids percentages. For this reason, optimum conditioning of palm fruit mesocarp to render it suitable for solvent extraction is difficult to achieve at reasonable cost. As well as being economically unattractive there are other disadvantages including the explosion hazard, the dependence upon an outside supply of the solvent, the desirability of continuous operation, the impracticability of large-scale storage of fresh fruit bunches to ensure a steady supply in the plant, and the relatively high capital cost of solvent systems compared to mechanical expression systems.

THE OIL PALM – FERTILE *PISIFERA*

Chin, C. W. and Tang, T. L. (Felda Agricultural Services Corporation, Kuala Lumpur, Malaysia), *Planter, Kuala Lumpur*, 1979, **55**, 64–77

Fertile *pisifera* palms have the potential matching commercial *teneras*. The oil quality in terms of unsaturated fatty acid content is better and the oil/bunch ratio is higher. Preliminary testing on the milling of *pisifera* fruit bunches has shown that the present design can cope without major changes. The potential of *pisifera* as a parent with the South American *Elaeis oleifera* is discussed.

NEWS FROM SUPPLIERS (PALM OIL FACTORIES FOR HONDURAS)

Anon., *Food Processing Industry*, 1979, **48**, (12), 29.

Stork-Amsterdam have received a turnkey order from the Honduras Government for 3 complete palm oil factories. The order is worth 30 million Guilders (£6.7 million).

Palm oil mill effluent

PALM OIL MILL EFFLUENT: A REVIEW OF METHODS PROPOSED FOR ITS TREATMENT

Davis, J. B. (Tropical Products Institute, 56–62 Gray's Inn Road, London WC1X 8LU), *Tropical Science*, 1978, **20**, 233–262.

Methods are surveyed for dealing with the increasing quantity of the bulky, complex and intractable effluent produced during the industrial extraction of oil from oil palm fruits. These methods range from the traditional but increasingly unacceptable and wasteful method of removal by discharge into a nearby water course, to sophisticated multi-stage procedures yielding potentially useful by-products. Some of the methods have yet to be tested commercially whereas others are already in limited use. The topic has an urgency due to the continuing rapid increase in palm oil production, and the environmental and other disbenefits of failing to provide adequate methods of coping with the effluent. Since the subject is developing rapidly, it is not possible at this stage to identify an ideal method, or combination of methods, for treating the effluent: selection would depend on local circumstances and is liable to change as new ideas come to fruition. It is hoped that by collecting together details of all methods, with some of their advantages and difficulties, this review will provide a valuable basis for making decisions.

PALM OIL MILL EFFLUENT – A SUMMARY OF TREATMENT METHODS

Davis, J. B. and Reilly, P. J. A. (Tropical Products Institute 56/62 Gray's Inn Road, London, WC1X 8LU), *Oléagineux*, 1980, **35**, 323–330.

(In English. French and Spanish summaries, 12 and 13 lines)

After a brief introduction outlining the origin and composition of palm oil mill effluent, the scale of the associated

treatment problems and current legislative action, the authors outline in turn each of the many treatment methods which have been tried out on a laboratory or a commercial scale, or simply suggested, concentrating on those methods where useful by-products are obtained. Several of these methods are already being brought into commercial use, particularly in Malaysia.

CHEMICAL COMPOSITION OF PALM OIL MILL EFFLUENTS

Hwang, T. K., Ong, S. M., Seow, C. C. and Tan, H. K. (Universiti Sains, Malaysia, Penang, Malaysia), *Planter, Kuala Lumpur*, 1978, **54**, 749–756.

Chemical analyses of sludge and condensate effluents from a palm oil mill were carried out and the results are compared with previously published data. The analysis of the carbohydrate constituents was carried out in greater detail, in arriving at the quantitative data on total sugars, starch, pectin and pentosans. Preliminary study of the volatile components in the effluents shows the presence of acetic acid, butyric acid and isobutyl alcohol in both sludge and condensate and in addition, propionic acid in the condensate.

Oil palm products and their markets

MARKET DEVELOPMENT OF PALM OIL PRODUCTS

Proceedings of a seminar organised by the International Trade Centre, UNCTAD/GATT of the United Nations, 27 March – 1 April, 1978, Kuala Lumpur, Malaysia. viii + 184 pp. published by the International Trade Centre, UNCTAD/GATT, Geneva and printed at Percetakan Khee Meng, 214 Jalan Bandar, Kuala Lumpur, Malaysia (obtainable at M$12 per copy with postage extra M$3).

The proceedings contain 28 papers by various authors as follows:

'The world oils and fats economy – the broad picture', R. F. Hancock.
'Methods and assumptions in economic forecasts', C. P. Dunn.
'Methods and assumptions in technical forecasts of palm oil consumption', K. G. Berger.
'Review of main findings of the study', M. J. Powers.
'Forecasts of the palm oil report: comparison with actual', C. P. Dunn.
'Case study of developing markets – the Middle East', K. G. Berger.
'Production and consumption patterns of palm oil products in Malaysia', H. F. Khera.
'Fats and oils prices – introductory remarks', R. F. Hancock.
'Relationship of palm oils prices to all fats and oil prices', C. P. Dunn.
'Market distribution for palm oil', M. J. Powers.
'Price determination', D. H. N. Allott and I. C. H. Wong.
'Economics of further processing: the markets', C. P. Dunn.
'Malaysia's experience in the export of processed palm oil', R. M. Todd.
'The chemistry of palm oil and its products', K. G. Berger.
'Technical aspects of marketing quality palm oil', B. Bek-Nielsen.
'Quality during transport and storage', K. G. Berger.
'Quality and use of end products', K. G. Berger.
'The treatment of liquid wastes from oil palm fruit processing factories', D. A. M. Whiting.
'Land application of palm oil mill effluent', B. J. Wood.
'Non-food uses for palm oil', M. K. Schwitzer.
'Tariffs and other Government policies affecting the fats and oils markets', R. F. Hancock and R. M. Todd.
'Palm oil contracts', J. D. Menneer.
'The future market: a scenario into the 1980's', C. P. Dunn.
'The future market: a scenario into the 1980's; a comment with additions', R. F. Hancock.
'The need for technical training – a course on the chemistry and technology of palm oil', A. S. H. Wong and K. G. Berger.
'Research needs of the palm oil industry', K. G. Berger.
'Promotional and marketing options for palm oil products', R. F. de Viana.
'Summary and review', M. J. Powers.

SUBSTITUTION BETWEEN VEGETABLE OILS AND THE TRADE OF DEVELOPING COUNTRIES

Nusbaumer, J. and Franco, R. (GATT Secretariat, Centre William Rappard, Rue de Lausanne 154, CH-1211 Geneva 21, Switzerland), *Tropical Science* 1978, **20**, 35–58.

The technical characteristics and end-uses of the following vegetable oils are outlined: palm, groundnut, coconut, palm kernel, linseed and castor. The possibilities of substitution between these oils, other fats and oils and synthetic products are emphasised. The interchangeability of products of the fats and oils sector has increased as a result of progress in oil refining and processing techniques. This has tended to reduce the dependence of the processing industries on particular sources of supply of oil-bearing materials. Under certain conditions it encourages the location of these industries close to the sources of these materials. Greater competition between different oils and oil derivatives reduces the effectiveness of existing protective structures in developed importing countries; this may pose problems for the maintenance and development of traditional trade flows, particularly as regards the exports of developing countries. The paper concludes that in view of the complexity of the inter-relationships between different products of the fats and oils sector, the maintenance of stability in the relevant world markets requires an integrated trade policy approach embracing as many of these products as possible.

THE PALM OIL SITUATION

Doak, T. E. (Lever Bros. Co., 390 Park Avenue, New York, New York 10022, USA), *Journal of the American Oil Chemists' Society*, 1978, **55**, 599A–600A.

In broad perspective, total world demand for oils is growing rapidly, and palm oil will be seen in future years as a welcome addition to total world supply. It also seems clear that palm oil utilisation is broadening at a faster rate than production is increasing. It appears that this utilisation is growing fastest in the 'new markets' of Asia, the Middle East, and Latin America, rather than in the 'old markets' of Europe and the United States of America.

RED PALM OIL AVAILABLE FROM OIL PALM INDIA

Anon., *Oils and Oilseeds Journal*, 1979, **31** (4), 18.

Oil Palm India Ltd, Kottayam 4, Kerala State, India, the only large-scale indigenous cultivator of oil palm, states that it is in a position to supply about 10 tonnes of red palm oil every month. This quantity is likely to increase when more areas already cultivated with oil palms come into yield. Sales will be effected on the basis of competitive tenders invited from a registered list of buyers from time to time.

NEW PALM OIL BULKING STATION IN THE SOLOMON ISLANDS

Anon., *Pacific Islands Monthly*, 1976, **47**, (11), 59.

A new palm oil bulking station at Point Cruz in Honiara was commissioned earlier this year. The station, with a storage capacity of 5,000 tonnes, processes oil delivered by road tanker from a mill, also recently built, outside Honiara. Both the mill and the bulking station were built on the initiative of the Commonwealth Development Corporation, London. These facilities are expected to contribute significantly to the economic development of the Solomons. The contract for the design and construction of the bulking station was awarded to Evans Deakin Industries of Queensland, Australia.

INDONESIA RAISES PALM OIL/KERNEL PRODUCTION

Anon., *Public Ledger*, January 25, 1980, p. 3.

According to the USDA, Indonesian palm oil production rose to almost 500,000 tonnes in the first 10 months of 1979 from 426,000 in the corresponding 1978 period and palm kernel production to 93,000 tonnes from just under 80,000 tonnes. Stocks of palm oil at the end of October, 1979 were 2,000 tonnes below the 51,000 tonnes of 1978 while palm kernel stocks rose from 8,000 to 9,000. Indonesia is known to be encouraging domestic consumption of palm oil because it is a cheap substitute for coconut oil. 'Indonesia's expansion of palm oil substitution of coconut oil will cut back the growth rate in palm exports flowing into major world markets and, at the same time, free more coconut oil', the Department said.

OLEOCHEMICALS AND DETERGENTS FROM THE O PALM

Schwitzer, M. K. (Technical Consultant, 33 Shepherds Hi London N6 5QJ, England) PORIM Seminar paper G. 101 paper from a seminar lecture organised by the Palm Oil Research Institute of Malaysia, 13 August, 1979, Kuala Lumpur, 15pp.

The article reviews the raw materials used in fat splitting and a statistical assessment of the fatty acid industry is attempted. Principal categories of oleochemicals are brief discussed.

The essential technical features of the fat splitting process are discussed as well as the main technical and economic aspects of the subsequent processes for treating the split fatty acids. These processes are distillation, fractional distillation, cold separation and hydrogenation. It appears that some of the potentially more profitable processes, suc as fractional distillation, are currently impractical for Malaysian conditions due to lack of markets for the products in the area. Fatty acid plants show poor returns on investment which is the same in the developed countries. They have the merit, however, of supplying the feedstock for 'down-stream' developments.

Fatty alcohols are one of the 'down-stream' chemicals mad from fatty acids. Alternatively they are being manufacture by methanolysis of oils via the methyl ester. Both processes are being discussed and their economics compared. Both show DCF returns of 40% after tax. Fatty alcohols – as their sulphates or ether sulphates – have a good market in shampoos and other detergents. It is argued that once price parity between alcohol-derived detergents and petrochemical derived LAS type of detergents is approaching, a dramatic increase in the use of fatty alcohols must be expected. Alcohol sulphates would then regain the important position they held before the cheaper petrochemical sulphonates burst on to the scene after the last war. The author considers that Malaysia is singularly well placed to provide fatty alcohols for the whole area in that event.

Palm oil/palm kernel oil processing

METHOD FOR REFINING PALM OILS

Watanabe, H. and Negishi, M. (Showa Sangyo Kabushiki Kaisha, Tokyo, Japan), *US Patent 4,113,752*, September, 12, 1978.

This invention relates to a method for the refining of palm type oils such as palm oil and other similar natural oils inclu

ng palm kernel oil, coconut oil and the like. The method includes adding a small quantity of phosphoric acid to a crude palm-type oil, treating the said oil to steam refining at 200–270°C with the blowing of superheated steam into the oil under vacuum after the activated clay has been removed.

PHYSICAL REFINING OF PALM OIL
(Physikalische raffination von Palmöl)

Aalrust, E. (Lurgi Umwelt und Chemotechnik GmbH. Forschungslaboratorium, Gwinnerstrasse 27–33, 6000 Frankfurt/Main 6, Federal Republic of Germany), *Fette Seifen Anstrichmittel,* 1978, **80**, 342–344.

(In German. English summary, 12 lines)

In contrast to conventional neutralisation which consists of several steps, physical refining is composed to two main processing steps, namely continuous de-liming-prebleaching and deodorisation integrated with distillation of the free fatty acids. The use of minimum amounts of chemicals under vacuum assures no pollution of waste water. Moreover, the direct recovery of fatty acids by distillation eliminates the cumbersome process of splitting the soapstock. Other advantages of this process are the reduction of refining loss and a higher purity of the recovered fatty acids. Results obtained in a new physical refining plant having a capacity of 200 tonnes per day are given.

APPLICATION OF SUPERCENTRIFUGE WITH TUBULAR BOWL TO THE REFINING OF VEGETABLE OILS
(Application des supercentrifuges à bol tubulaire au rafinage des huiles végétales)

Lévèque, A. (Société Sharples-Stokes, B P 204–92505, Rueil-Malmaison, France), *Oléagineux,* 1977, **32**, 539–544.

(In French: English and Spanish summaries, 7 and 9 lines)

Simple and robust in construction, the supercentrifuges with tubular bowl can develop a centrifugal force equal to 15,000 times the gravity field. Such performance makes them the ideal aparatus for separating the soap-stocks in vegetable oil refining processes. Round its supercentrifuges, Sharples have developed refining units adapted to the nature of the oils to be processed.

PROCESSING OF TROPICAL FATS AND OILS: REFINING AND FRACTIONATION OF PALM OIL
(Traitement de valorisation des corps gras tropicaux: raffinage et fractionnement de l'huile de palme)

Pairaud, D. (H. S. L. Blohorn S A, B P 1751, Abidjan, Ivory Coast), *Revue française des Corps Gras,* 1979, **26**, 5–8.

(In French. English, German, and Spanish summaries, 4, 5 and 5 lines)

The main unit operations of refining and fractionation for palm oil are reviewed. The various uses of palm oil in the food and industrial fields are expounded. The author considers palm oil as a new product with many utilisation possibilities which have not yet been studied.

CONTINUOUS SOLVENT FRACTIONATION OF PALM OIL
(Fractionnement continu par solvant de l'huile de palme)

Bernardini, M. (SpA Costruzioni Meccaniche Bernardini CMB, Rome, Italy), *Oléagineux,* 1978, **33**, 297–305.

(In French. English and Spanish summary, 8 and 10 lines)

The CMB process for the fractionation of crude palm oil by continuous crystallisation using hexane as the solvent is described. The materials used and the processing cycle are detailed. They comprise fractionation, continuous thermal bleaching of the fractionated palm oil; filtration of the oil/bleaching earth suspension through special filters assuring total recovery of oil from the earths, and combined neutralisation and deodorisation of the bleached oil in a single operation.

STUDY OF THE FRACTIONATION OF PALM OIL OBTAINING A LIQUID OIL OF IODINE VALUE BETTER THAN 75 AND THE CHARACTERISTICS OF THE RESULTING PRODUCTS
(Étude sur le fractionnement de l'huile de palme. Obtention d'une huile fluide d'indice d'iode supérieur à 75 et caractéristiques de produits résultants)

Klein, J. M. (Lesieur-Cotelle et Associés, 101 Route de Bourbourg, 59210 Coudekerque-Branche, France), *Oléagineux,* 1979, **34**, 531–536.

(In French. English and Spanish summaries, 9 and 11 lines)

The advantage of fractionating palm oil to extract its fluid fraction is underlined. To enable this fluid fraction to be used in temperate climates without a deposit forming at 15°C, it is essential that the maximum content in trisaturated triglycerides and disaturated-monounsaturated triglycerides should not be exceeded. The different criteria to be respected in order to obtain a fluid fraction comparable to groundnut oil as regards stability when cold are reviewed. The triglyceride composition of the fractions recovered is also examined.

FRACTIONATION OF PALM OIL BY SELECTIVE CRYSTALLISATION ON A CHILLED SURFACE
(Fraktionierung von Palmöl durch selektive Kristallisation an einer gekühlten Fläche)

Hahn, G. (Institut für Lebensmittelverfahrenstechnik der Universität Karlsruhe, Kaiserstrasse 12,7500 Karlsruhe, Federal Republic of Germany), *Fette Seifen Anstrichmittel,* 1978, **80**, 337–342.

(In German. English summary, 11 lines)

A new process for the fractionation of palm oil was studied, which enables the crystallisation and separation of the components in a single processing step. The higher melting fraction is selectively crystallised on a chilled surface, while the lower melting fraction is enriched in the liquid. The influence of processing parameters on the separation was studied experimentally. It was found that the extent of separation is determined by the rate of growth of the phase interface, thickness of the boundary layer between the phase boundary and the liquid, and time of fractionation. Optimum conditions are given for all parameters.

ON PALM OIL TREATMENTS. VI: OIL WHICH IS PERMANENTLY CLEAR AT LOW TEMPERATURES
(Sulla lavorazione dell'olio di palma. VI: Olio di limpidita stabile a bassa temperatura)

Martinenghi, G. B. (L. D. Universita di Milano, Associazione Aitoga, Milano, Italy) and Grieco, D. (Laboratorio di Chimica e Microscopia, Associazione Granaria, Milano, Italy), *Rivista Italiana delle Sostanze Grasse,* 1977, **54**, 116–119.

(In Italian. English summary, 16 lines)

The critical examination of the most recent literature on this subject and the experimental data obtained in the present study, show that a fluid oil, prepared from a palm oil, which is permanently clear at 5–6°C, can be economically acceptable only when it is synthesized from the distilled fatty acids recovered from the palm oil physical refining. The following treatments are described: distilled acid fractionation with aqueous methanol in solid and liquid acids, esterification of the liquid fraction with glycerol, and physical refining of the esterified oil. This refined oil does not cost more than the refined whole palm oil and has the following main characteristics:

Initial cloud point: –22°C, setting point: –25°C, flow point: –3°C, clear point: 3°C (permanently clear at over 5–6°C). Fatty acid composition (GLC), per cent: C12:0 0.4, C14:0 1.9, C16:0 6.5, C16:1 0.5, C18:0 0.7, C18:1 72.2, C18:2 17.6, C18:3 0.2.

Palm oil properties, composition and standards

A STUDY OF THE STABILISATION OF WHOLE CRUDE, ONCE-REFINED AND OXIDISED-CRUDE PALM OIL WITH TENOX TBHQ ANTIOXIDANT

Eastman Chemical Products, Inc., USA (reproduced from publication No. ZG-215B) *Planter, Kuala Lumpur,* 1979, **55**, 206–234.

The article reproduced from the Eastman Chemical Products, Inc. publication is to report work done in its laboratories on how the oxidation rate of crude palm oil and its components can be reduced. The work was carried out on whole crude palm oil, once-refined crude palm oil, and whole-oxidised crude palm oil to cover three major types.

It was found that once-refined crude palm oil oxidises at a substantially faster rate than does whole crude palm oil. Once-refined oil is responsive to TBHQ treatment and at 150 p.p.m. of TBHQ, the oxidation rate of once-refined oil is no worse than that of whole crude oil. The benefits of using citric acid in combination with TBHQ are more demonstrable in old oxidised crude oil. Optimum TBHQ and citric acid levels to provide best response are shown by tabulated figures.

CHANGES IN PALM OIL QUALITY DURING PROLONGED STORAGE IN DIFFERENT TYPES OF DRUMS

Eapen, P. I. (NIFOR, PMB 1030, Near Benin City, Nigeria) 'Technical consultation on oil crops for West and Central Africa', Benin City, Nigeria, 21–26 November, 1977, Food and Agriculture Organization of the United Nations document AGP:OC/77/16, October 1977.

Special grade palm oil was stored in different types of drums and samples taken periodically were analysed for the various quality and identity characteristics over a period of 126 weeks' storage. Quality characteristics as represented by f.f.a., carotene content and peroxide value were found to change appreciably in all cases. As for iron content, remarkable change was observed only in the case of unlined drums. The other characteristics of the stored oils, such as iodine value, volatile matter, and residual colour remained practically unchanged during the entire period of storage.

The f.f.a. content for the various treatments though steadily rising, was almost the same for all the treatments for the same period of storage. But this was not so for carotene and peroxide values. Palatability of the oil at the end of the period of storage was also found to be different for the different types of drums. Of the various types of drums used, resin lined drums were found most suitable for the prolonged storage of palm oil.

PALM OIL, ITS POLYMORPHISM AND SOLIDIFICATION PROPERTIES
Persmark, U., Melin, K. A. and Ståhl, P. O. (Research laboratory, AB Karlshamns Oljefabriker, Karlshamn, Sweden), *Rivista Italiana delle Sostanze Grasse,* 1976, **53**, 301–306.

(In English. Spanish summary, 13 lines)

The solidification behaviour and the polymorphic properties of palm oil has been investigated by means of X-ray defraction, dilatometric measurements and cooling curves. These characteristics are related to its chemical composition and with respect to time and temperature factors. Effects from surface active components are also included.

X-ray defraction analyses shows that palm oil above 23°C solidifies directly in β'-phases. The condition for formation of α-phases is that the oil is rapidly cooled below 20°C.

The $\alpha \rightarrow \beta'$-transition, mainly localised in the so-called middle fraction is slowest at 5–10°C and can vary considerably due to the presence of surface active components. Important base parameters for the solidification behaviour of palm oil seem to be this $\alpha \rightarrow \beta'$-transition and solubility interactions of triglycerides.

THE DSC THERMAL ANALYSIS OF CRYSTALLISATION BEHAVIOUR IN PALM OIL

Kawamura, K. (Best Foods Research Center, Division of CPC International Inc., Union, New Jersey, 07083, USA), *Journal of the American Oil Chemists' Society*, 1979, **56**, 753–758 and 1980, **57**, 48–52.

Polymorphic behaviour of palm oil crystals was studied by means of differential scanning calorimetry (DSC) under isothermal and constant cooling conditions.

Part I deals with isothermal conditions, and microscopic observation shows that different crystal forms develop specific spherulites depending on the degree of supercooling from the melt. The A-form crystal was capable of forming a dotted spherulite and the B-form crystal of forming a dendritic spherulite. Experimental results of B-form crystallisation studied by the DSC and a microscope under kinetic conditions were evaluated using Avarami's theory, since the behaviour of the oil during crystallisation related well to that of high polymers. The crystallisation process was divided into nucleation and crystal-growth phases to facilitate the theoretical treatment similar to that of high polymers, providing crystals possessing overall structural regularity.

In the second part, investigation by means of DSC under constant cooling conditions produced β'_1 crystals mixed with α, and β'_2 crystals. All underwent the typical transformations to the more stable forms i.e. $\beta'_2 \rightarrow \alpha \rightarrow \beta'_1 \rightarrow \beta$. Isothermal conditions produced: (a) α crystals mixed with β'_1, (b) transformation from them to β_1, and (c) β_2 and β_3 crystals. In palm oil crystals, sorbitan tristearate retarded the transformation of the unstable α and β' forms to the stable β form. This retardation, however, was greatly influenced by the cooling and heating conditions. Using that property of sorbitan tristearate, the polymorphic behaviour of palm oil crystals could be studied in detail.

COMPARATIVE STUDY ON THE COMPOSITION OF PALM OILS FROM DIFFERENT VARIETIES OF PALMS OF THE GENUS *ELAEIS*

(Compositions comparées d'huiles de palme provenent de différentes espèces de palmiers du genre *Elaeis*)

Faulkner, H. (B P 329, Freetown, Sierra Leone) Bonfand, A. and Naudet, M. (Laboratoire Nationale des Matières Grasses, ITERG, et Laboratoire de Chimie des Corps Gras, Université d'Aix-Marseille, 13331 Marseille Cedex 3, France), *Revue française des Corps Gras*, 1978, **25**, 125–133.

(In French. English, German and Spanish summaries, 9, 10 and 12 lines)

Palm oils from the fruit pulp of *Elaeis melanococca* (Syn *oleifera*), *E. guineensis* and *E. melanococca* x *E. guineensis* hybrid have been compared with regard to the fatty acid composition, glyceride structure and the composition of the unsaponifiable matter. This study shows that the oil from the hybrid has an intermediate consistency between that of the two species. It has specific characteristics concerning its fatty acid composition and distribution, glyceride structure and composition of unsaponifiable matter.

DEVELOPMENT OF A METHOD FOR DETERMINING TRISATURATED GLYCERIDES IN FATS AND OILS. APPLICATION TO PALM OIL AND ITS FRACTIONS

(Mise au point d'une méthode de dosage des glycérides trisaturès dans les matières grasses – Application à huile de palme et ses fractions).

Bouvron, C. (Laboratoire H S L Blohorn, B P 1751, Abidjan, Ivory Coast), *Revue française des Corps Gras*, 1979, **26**, 17–21.

(In French. English, German and Spanish summaries, 6, 8, and 8 lines)

After the fat is oxidised by potassium permanganate in acetone, the unchanged saturated glycerides are extracted and directly determined by gas-liquid chromatography. Quantitative results are possible thanks to the use of an internal standard (trimyristin) and response coefficients for each glyceride. This method is applied to solid and liquid fractions from palm oil.

TRIGLYCERIDE STRUCTURE OF *ELAEIS GUINEENSIS* VAR. *TENERA* AND A HYBRID OF *E. GUINEENSIS* AND *E. MELANOCOCCA*

Berger, K. G. (Palm Oil Research Institute of Malaysia 18th Floor, Angkosa Raya Building, Jalan Ampang, Kuala Lumpur), Hamilton, R. J. and Tan Boon Keng (Chemistry and Biochemistry Department, Liverpool Polytechnic, Liverpool, UK), *Chemistry and Industry*, 1978, (11), pp. 383–384.

This paper contrasts the triglyceride structure of palm oil and the stearin and olein fractions obtained from acetone with those obtained from the hybrid. It was found that for both oils the fatty acid compositions of the oleins are quite similar to those of the original crude oils, whereas the stearins are much more saturated. The proportions of the

triglyceride classes in the oleins are also very similar to the original oils, the largest numerical difference obtained being in the triolein content of the hybrid at 18.7% in the oil and 21% in its olein. In the hybrid olein, the triglyceride classes are present in proportions very similar to those of salad oils, the linoleic acid content is closer to olive oil and much lower than in cottonseed or corn oil. The hybrid stearin is somewhat similar to the whole *tenera* oil, the largest difference being in the UUS glycerides at 29.2% and 34.3% respectively. Another difference, which is potentially of practical significance, is that hybrid stearin has a higher content of SUS glycerides than the *tenera* oil, or either of its fractions. The hybrid stearin would, therefore, appear to be a better starting point than *tenera* oil for further fractionation to produce a cocoa butter-like material.

VARIATION IN THE FATTY ACID COMPOSITION OF PALM OIL

Ng, B. H., Corley, R. H. V. (Oil Palm Physiology Unit, Malaysian Agricultural Research and Development Institute, Layang-Layang, Jahore, Malaysia) and Clegg, A. J. (Harrisons & Crosfield Oil Palm Research Station, Banting, Selangor, Malaysia), *Oléagineux,* 1976, **31**, 1–8.

(In English and French. Spanish summary, 10 lines)

The variations in the fatty acid composition between bunches, palms and fruit types of *Elaeis guineensis* and between species of *Elaeis* have been studied in several trials. Methods of sampling are defined to characterise a bunch, a palm and a group of palms. From the repeatability obtained in studies of sampling between bunches from the same palm, heritabilities have been estimated for the different fatty acids. Suggestions are made regarding the use of the varieties observed to improve the quality of the oil; the origin of the varieties is discussed.

THE EFFECT OF β-CAROTENE ON THE STABILITY OF PALM OIL

Meara, M. L. and Weir, G. S. D. (Food Research Association, Leatherhead, England), *Rivista Italiana delle Sostanze Grasse,* 1976, **53**, 178–180.
(In English. Italian summary, 25 lines)

Palm oil is unusual in its relatively high cholesterol level and is unique in having a characteristic carotenoids content in the crude oil. The literature is contradictory in describing β-carotene, the main carotenoid present in palm oils as both a pro- and anti-oxidant. β-carotene is thought to be implicated in the formation of a brown pigment in those palm oils which are difficult to bleach. The effect of β-carotene other than in the formation of the brown pigment on stability has been considered. The kinetics of β-carotene oxidation have been studied in model systems, and some of the reaction products identified. A mechanism is proposed for the oxidation of β-carotene. A rather different situation exists when considering the photochemical aspects of the stability of crude palm oils. Palm oils show variable induction periods by the FIRA-Astell accelerated stability test. The results for crude and refined, deodorised and bleached material are very different, and the effect of added β-carotene can be clearly shown; and perhaps compared with the better known effects of transition metal catalysis. The breakdown of β-carotene is mainly oxidative rather than purely thermal at the temperature of this accelerated test, which is 100°C.

VITAMINS AND OTHER NUTRIENTS: APPLICATION OF GEL PERMEATION CHROMATOGRAPHY AND NONAQUEOUS REVERSE PHASE CHROMATOGRAPH TO HIGH PRESSURE LIQUID CHROMATOGRAPHIC DETERMINATION OF RETINYL PALMITATE AND β-CAROTENE IN OIL AND MARGARINE

Landen, W. O. and Eitenmiller, R. R. (Food and Drug Administration, 880 W Peachtree Street, NW, Atlanta, GA 30309, USA), *Journal of the Association of Official Analytical Chemists,* 1979, **62**, 283–289.

A high pressure liquid chromatographic method has been developed using high-pressure gel permeation chromatography (HP-GPC) and high-pressure reverse phase chromatography (RP-HPLC) for quantitation of retinyl palmitate and β-carotene. HP-GPC was used for fractionation of vitamin A active compounds from oil preliminary to quantitation on nonaqueous RP-HPLC. HP-GPC fractionation was completed on oil and margarine dissolved in methylene chloride by 2 elution passes through 2μ Styragel (100Å) columns connected in series with methylene chloride as the mobile phase. RP-HPLC separation of retinyl palmitate and β-carotene was achieved on μBondapak C18 (100μm), using methylene chloride-acetonitrile (30 + 70). Based on 10 repetitive analyses, recoveries of added β-carotene and retinyl palmitate from vegetable oils were 98.6 plus ± 2.9% and 95.2 ± 2.6%, respectively. Coefficients of variation were 2.9% for β-carotene and 2.7% for retinyl palmitate. The determination of vitamin A activity in 7 margarine brands with label claims of 10% US RDA/serving revealed that all but one of the margarines contained at least 94% of the label claim. Vitamin A activity in the margarines ranged from 90.6% to 110.8% of the label declaration.

A COLLABORATE STUDY OF UNIFORM TEST METHODS FOR PALM OIL

Yeoh, G. H. (Technichem Laboratory Services, 350-G, Block 1, Balestier Hill Shopping Centre, Thomson Road, Singapore 11), *Planter, Kuala Lumpur,* 1978, **54**, 461–474

This article is a follow-up of two earlier ones (*Oil Palm News*, 1977, (22), p. 38) concerned with improving palm oil test methods. It presents the results of an inter-laboratory cross-check exercise on uniform test methods for some basic palm oil properties. Much better agreement in test results among the 15 participating local laboratories as observed in respect of the determinations of free fatty acid, volatile matter, insoluble impurities and peroxide value of palm oil, as compared to the previous exercise where the participants were allowed to use their normal routine technique for analysis. Details of the proposed test methods are described.

PALM OIL STANDARDS IN RELATION TO MARKETING AND REFINING BEHAVIOUR

Chin, A. H. G. (Palm Oil Technology Laboratory, MARDI, Serdang, Selangor, Malaysia), *Planter, Kuala Lumpur*, 1979, **55**, 414–439.

In order to improve its share in the edible oil market, palm oil must be reliable and consistent in quality. The manufacturer requires an oil that neutralises with least loss and is easy to bleach and deodorise. Buyers would be assured by standard specifications, which would lead to proper control of production and handling. The chemistry of triglycerides is complex and the methods of analysis accordingly diverse – but appropriate development of standard methods and a system of regulation is currently taking place.

COMPARISON OF THE GLYCERIDE STRUCTURE OF COPRA AND PALM KERNEL OIL I – TOTAL FATTY ACIDS AND TRIGLYCERIDE GROUPS; II – FATTY ACID COMPOSITIONS OF THE TRIGLYCERIDE GROUPS; III – TYPES OF TRIGLYCERIDES

(Comparison de la structure glycéridique des huiles de coprah et de palmiste. I Acides gras totaux et groupes de triglycérides; II Compositions en acides gras des groupes de triglycérides; III Types de triglycérides)

Bugaut, M. and Bezard, J. (Laboratoire de Physiologie Animale et de la Nutrition, Université de Dijon, 21000 Dijon, France), *Oléagineux*, 1977, **32**, 277–282; 1978, **33**, 129–134; 1979, **34**, 77–87.

(In French. English and Spanish summaries, 13 and 14 lines)

In this extensive study of these lauric oils, modern chromatographic analysis methods are used to determine their composition and fatty acid and triglyceride groups. Although the raw materials (palm kernel and coconut meat) are very different, the mode of biosynthesis of their reserve fats is comparable; in effect, both copra and kernel oils have identical fatty acid and glyceride structures. To reach this conclusion, the authors have carried out a considerable amount of analytical work and compared the experimental results with those calculated using random distribution formulae.

Palm kernels/palm kernel oil

THERMOPHILIC FUNGI AND THE DETERIORATION OF NIGERIAN OIL PALM KERNELS

Oso, B. A. (Department of Botany, University of Ibadan, Ibadan, Nigeria), *Economic Botany*, 1979, **33**, 58–62.

Both palm oil and the palm kernels constitute produce which is of great economic importance to Nigeria. Palm produce is susceptible to attack by fungi during processing and in storage which results in its deterioration. Six thermophilic fungi previously isolated from palm kernels in Nigeria were found in the present study to grow well on the palm kernel, reducing its oil content and increasing its free fatty acid (f.f.a.) fraction. Reduction in oil content and increase in f.f.a. fraction were studied in relation to the time course of growth of these fungi at 45°C over a period of 20 days. Temperature was found to affect oil utilisation and the f.f.a. production. The results indicate that these thermophilic fungi are economically important, causing biodeterioration of plant produce in nature.

Training

The Bureau is prepared to advise management in the oil palm industry on the training of personnel. Details of the nationality, linguistic abilities and educational background of the candidate would be needed, together with the purpose for which training is required.

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The Tropical Products Institute has one of the world's best libraries of periodicals and works of reference dealing with the products of developing countries and photo-copies of articles dealing with the oil palm can be provided on request. Answers to technical queries concerning the oil palm can also be dealt with; certain agronomic or engineering inquiries might have to be referred outside the Institute, but the Secretary of the Bureau would endeavour to find the best source of information.

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The following abbreviations are used:

CDC	Commonwealth Development Corporation
EC	European Community
IRHO	Institut de Recherches pour les Huiles et Oléagineux
NIFOR	Nigerian Institute for Oil Palm Research
UNCTAD/GATT	United Nations Conference on Trade and Development/General Agreement on Tariffs and Trade
USDA	United States Department of Agriculture

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